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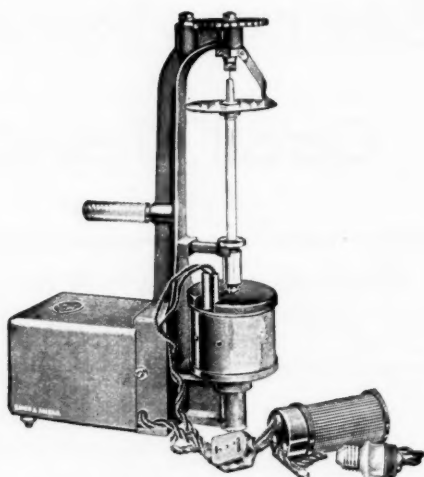
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The Act of Shortening in Baking Together With a Plea for More Physical Tests on Baked Goods

By WASHINGTON PLATT,

Manager Technical Service Dept., Merrell-Soule Company.

(A paper read at the Convention of the American Association of Cereal Chemists, June 5, 1923.)

When eating any food we experience a variety of sensations some of which may be pleasant and others the reverse, the sum of which makes up the "eating qualities" of any food. The first of these sensations is the taste proper, tho the word taste is often loosely used to include all of the sensations produced when food is eaten. Strictly speaking the taste is the sensation given by the organs of taste at the base of the tongue. These sensations are relatively simple, being confined to sensations of sweetness, sourness, bitterness, and saltiness, with possibly a very few other elementary tastes. We experienced also the sensation given by the organs of smell. These sensations are often considered part of the taste but should more properly be called the odor or flavor of food. This sensation is given entirely by the volatile constituents. Another set of sensations is of equal importance to the other two. For lack of a better term I will call this "the chewing properties" of the food. It is, namely, the physical feeling which the food gives us in our mouths. The food for example may be tough or tender, hard or soft. It may dissolve easily or it may be unsoluble or gummy. These chewing properties have much to do with the pleasure of eating. They are also closely associated with digestibility, as foods which are tender and dissolve easily are more quickly and thoroughly attacked by the digestive juices.

The chewing properties are also of tremendous money value. Consider for example the difference between a tough and a tender steak. Certainly both of them would have the same effect on our organs of taste and smell but one of them is unpleasant to eat, undigestible and brings a low price per pound, the other is just the reverse and its price is in fact largely fixed by its tenderness.

Consider also any of the standard ginger snaps on the market made with shortening. They are popular with the public, command a fair price, and are sold to the extent of thousands of pounds each year. The same snaps made in exactly the same way except for the omission of shortening would have the same appearance and would give practically the same sensations to our organs of taste and smell. A snap made without shortening, however, would be as hard as a piece of wood and would hence be deficient in its chewing qualities which are so important. Such snaps would be impossible to sell in any quantity at any price. The chewing properties of a food are, therefore, of the first importance from many points of view.

In biscuit baking all of the ingredients as well as the methods of handling have an effect upon the final chewing properties. However, the one ingredient which has by far the largest effect is shortening and it is this ingredient which we will consider. The fundamental effect of shortening is to make any baked product easier to break. For the sake of clearness we may take the following definition:—"Shortening is any fat or

fixed oil used as an ingredient in baked products. That material has the greatest shortening power, which when baked in a dough under standard conditions gives to the product a minimum breaking strength and a minimum crushing strength."

The present paper is a review of the action of shortening in baked goods and an attempt to determine some of the reasons for the difference in the shortening power of various fats and oils. We will confine our consideration to the ordinary sugar cookies including ginger snaps, but much of what is said will be of general application to all types of baked goods. In some baked goods, however, the principles here set forth will be overshadowed by other factors.

A biscuit of the kind named would contain:—

Flour
Sugar
Ammonium-Bicarbonate
Monocalcium-acid-phosphate
Bicarbonate of Soda
Water
Shortening.

If we should mix a dough of this kind without shortening we would find that all of the ingredients are either soluble in water or wetted by it. Such a dough is essentially a concentrated solution of sugar, certain inorganic salts, and proteins in which are soaking the starch grains and insoluble proteins of the flour. Such a dough is, therefore, essentially a continuous mass and it remains so after baking. It may contain holes due to the formation of gas but the biscuit forms a solid continuous mass around these holes just as cement may form a continuous mass around the stones which are mixed into it. Such a biscuit made without shortening is as hard as a piece of wood.

If we now add any form of shortening to such a dough we introduce an ingredient of a kind entirely different from any of the others, in that shortening is the one ingredient in the dough which is not soluble in water or wetted by it. Shortening must, therefore, remain distinct from the rest of the dough. It does in fact distribute itself thru the dough in droplets or layers often coating the starch grains and strands of gluten. This structure of the shortening extending throughout the mass but remaining distinct from the other ingredient can in fact be seen in the dough and in the finished biscuit under the microscope by the proper methods of staining.

What is the effect of the shortening distributed thru the biscuit in this manner? Suppose we should try to glue together two pieces of wood with greasy surfaces. They would not stick together because the layer of grease would prevent the glue from forming a firm contact with the wood. Suppose again, we should attempt to make concrete using stones which had been soaked in oil. We would find that the cement would not stick to the stones and that the films of oil distributed in such a manner would make cracks and faults which would make the whole structure crumble so that it would have comparatively little strength. Exactly the same effect is brought about by the shortening in a biscuit. It extends in layers throughout the dough and prevents the different parts of the dough from coming into contact and forming a solid mass. Shortening forms as it were a multitude of minute cracks in the dough or finished biscuit which prevents it

from forming a continuous mass. This action of shortening is similar to the action of paraffin paper used in wrapping caramels. Without these thin layers of paraffin paper a box of caramels would become one solid mass. Such then is the fundamental action of shortening.

In these ideas I find that I have been to a certain extent anticipated some fifty years by the well known scientist Tyndall in his book "Fragments of Science." Speaking of pastry, Tyndall says, "The volition of the pastry cook has entered into its formation. It has been his aim to preserve a series of surfaces of structural weakness, along which the dough divides into layers."

Such an action will be characteristic of any oil or fat whether of animal, vegetable, or mineral origin. We find, however, that there is a tremendous difference in the shortening powers of different oils and fats. Mineral oils have much less shortening power per pound than the fatty oils and among the fatty oils we find differences. It takes for example fifteen or more pounds of cocoanut oil to get the same shortening effect in a biscuit as ten pounds of cottonseed oil. Let us see what are some of the factors governing the shortening power of the various shortenings. The viscosity and surface tension against air are not controlling factors as fats having the same viscosity and surface tension differ widely in shortening power. Similarly the melting point alone is not a primary factor.

The plasticity of the shortening at the temperature of mixing seems to be a factor of the first importance. Plastic fats are mobile enough so that they extend thru the dough in the process of mixing, yet they hold their shape and position so that the films of fat do not run together and finally run out of the dough. Such fats seem to hold gas better than others. We find, therefore, plastic fats such as lard and lard compounds at the head of the list in shortening power. Another factor of the first importance seems to be the content of unsaturated glycerides which each fat contains.

The following list shows the percentage of unsaturated glycerides in the common shortenings:—

Cotton-seed Oil	75%
Lard	60%
Lard Compound	60%
Butter	38%
Cocoanut Oil	5%
Liquid Paraffin	0%

If we arrange these fats in the order of their shortening power we find the following, (fats with the greatest shortening power being given first):—

Lard
Lard Compound
Cotton-seed Oil
Butter
Cocoanut Oil
Liquid Paraffin

It is quite noticeable that this order is nearly the same as that given above except that lard and lard compounds are both pushed ahead. This may be due to the fact that both of these shortenings are noticeably plastic at mixing temperatures.

Lanbmuir,¹ Harkins,² and others have shown that at the interface between two immiscible liquids the molecules tend to arrange themselves in a definite position. As Wilson and Banard³ express it, this is the position in which the molecules would be the most "comfortable." For example in a layer of fat on water the glycerine end of the molecule would extend towards the water and the hydrocarbon tails of the molecule would extend up into the fat.

These workers found that to saturate glycerides such as tripalmitin, tristearin, etc., occupied essentially the same space on the surface of the water. They found, however, in the case of unsaturated glycerides such as triolein that both the glycerine and the double bond part of the molecule was drawn down onto the surface of the water so that such molecules occupied nearly twice as much surface as the saturated molecules. Expressed in terms of shortening this would mean that unsaturated shortenings would cover twice as much of the surface of a dough as the saturated shortenings.

Langmuir's own words are "The saturated fatty acids cover approximately equal areas per molecule irrespective of length of hydrocarbon chain. The glycerides cover about the same area as the fatty acids obtained from them. The unsaturated fatty acids all cover much greater areas per molecule than the saturated. The double bond in oleic acid is thus apparently drawn down onto the water surface. It is interesting to note, however, that linoleic acid, with its two double bonds does not cover any greater area per molecule than oleic."

We see, therefore, that we cannot take the iodine number as such as a measure of the shortening power of a fat, inasmuch as trilinolein with an iodine number of 173 does not have any more covering power than triolein with an iodine number of 86. For this reason we must convert the iodine numbers of the shortenings into percentages of unsaturated glycerides before we can use these figures as a measure of shortening power.

Harkins and his co-workers have come to conclusions similar to those of Langmuir. They have also worked out the energy relations of oil and water interfaces, studying the total energy of the surface, work of cohesion, work of adhesion, spreading coefficient, etc. They find that "The presence of double bonds increases the cohesive work very slightly and the adhesional work very greatly," i. e. the presence of double bonds in a shortening not only cause it to cover more surface but such double bonds cause a fat to tend to spread and to adhere more closely to the surface of the dough which is covered.

It is very interesting to see how our conclusions regarding the influence of double bonds on shortening power parallel the conclusions of others on the influence of double bonds on lubricating power. Older workers on lubrication, especially on the conditions of static friction, realized that fatty oils had a lubricating power superior to mineral oils. They called this quality "oiliness" and it is rather amusing to see how some of the older writers tried to define and explain this quality of "oiliness." I remember about ten years ago the former Chief Chemist of the Pennsylvania Railroad attempted to explain to me the superior oiliness of lard

1. Met. Chem. Eng., 15 (1916), 468; J. Am. Chem. Soc., 39 (1917), 1848.
2. J. Am. Chem. Soc., 39 (1917), 354, 541; 42 (1920), 700, 43 (1921), 35.
3. Ind. Eng. Chem. 14 (1922), 683.

oil compared with any mineral oils. He knew that there was a real difference but he had an extremely hard time to explain just what it was. Being an honest man he did not try to cover up his ignorance in general remarks about surface tension. Wilson and Barnard³ and also Bingham⁴ have recently explained this property of oiliness as the attraction of the double bonds for the metal just as we have pointed out the connection between shortening power and the attraction of the double bonds for the aqueous constituents of the dough.

It would appear then that two very important factors in determining shortening power are the plasticity and the content of unsaturated glycerides in the shortening. In such a complicated mixture as a sweet dough no one would be rash enough to claim that these two are the only important factors concerned.

Before closing may I make an urgent plea for more actual physical measurements in the baking industry similar to those measurements which have proved of such great value in other industries.

In some fields of human endeavor knowledge is now so complete that we are enabled to predict the results which will follow from definite causes. For example, if a new electric motor or a new turbine is designed, experts can predict correctly the speed, horse power, efficiency etc. While such machinery will develop, the same thing is true of some branches of chemistry involving simple mixtures, dilute solutions, etc. these we feel that we understand the principal factors involved and that we are, so to speak, masters of the situation. In many other industries our knowledge is now, or was until recently, exceedingly incomplete. We may take as an example the iron and steel, cement, gelatin and baking industries. In all of these our knowledge of the real chemistry involved is extremely incomplete. We can seldom or never make predictions. The best that the scientist can do is to run along behind and attempt to explain in scientific terms what the practical man has already discovered. In such circumstances definite physical tests and measurements on the processes, and to determine the effects of certain ingredients and certain finished product often enable us to leap at one bound the intervening processes on the finished product.

The iron and steel, cement, and gelatin industries among many others are all excellent examples of the value of physical tests on the finished product at a time when the chemistry of the industries was very confused. Taking the one example of the iron industry. Rapid and definite progress was made in the past fifty years not because of chemical discoveries as to the fundamental reactions which took place, but because iron manufacturers knew the qualities which they wanted in their finished product and they had reliable and definite means of measuring such qualities which they wanted in their finished product and they had reliable and definite means of measuring such qualities, such as for example, hardness, tensile strength, elastic limit, etc.

Improvement was, therefore, assured and quite easy. Any one regardless of his knowledge of chemistry could test the effect of different ingredients on the quality of the finished iron and could continue to use those ingredients and those methods which give the qualities desired. The same is true of other industries. In the cement industry tests on

4. "Fluidity and Plasticity," New York, 1922.

strength in comparison, strength in tension, time of setting, etc., have enabled us to make ever stronger and stronger cement. In gelatin, tests on jelly strength, viscosity, etc., have enabled us to control these qualities, even tho we are still in the dark regarding the chemical reactions which take place. The same would be true in the baking industry if we should develop accurate physical tests.

We all remember hearing about the old days in the iron foundries. The old iron master judged the quality of his product by breaking a casting and examining the fracture noting the color, fineness of grain, etc. From these he drew his conclusions regarding changes in his mixtures and methods. These very practical men of those days learned to tell a surprising amount from such a simple examination. How old fashioned and unscientific such methods seem to us now when in a few minutes we can get with the greatest accuracy the hardness, tensile strength, elastic limit, etc. of any piece of iron and can record all of these qualities in permanent form and in such a way that the results can be checked up at any other place and at any other time.

Such methods were certainly old fashioned, but are they not closely parallel to the methods now used in examination of baked products such as bread? The old iron master broke the castings and examined the fracture, we cut a loaf of bread and examine the cut surface, punching and crushing it a little. We then go ahead and score the loaf a process which is indefinite at best and on which no two people have ever exactly agreed.

I do not mean to advocate the discontinuance of scoring bread as this method is certainly much better than nothing at all and has been the means of real progress in the past. What I would advocate very strenuously is some definite physical measurement on our finished product *in addition* to the present scoring. This same idea has been stated by Dr. Morison of the American Institute of Baking.

Let us determine the tensile strength of the bread, cutting out a piece of standard size and shape similiar to the standard block of cement or to the standard strip used in the textile and paper industries.

Let us also determine the compressibility of a standard cube of bread under a light load and the elasticity or degree to which such a cube would recover its normal shape, when the load is removed. Just as the surface of a jelly is tested with a plunger so the recently cut surface of a piece of bread could be tested with a properly shaped plunger and valuable and reproduceable data obtained.

Accurate machines for making all of these physical tests on many other materials are now on the market. Simple changes would enable them to be used for bread. Such measurements would help us to obtain absolutely definite results which could be recorded and compared with similiar measurements made at different laboratories or at different seasons. These measurements would give us a series of values which could be expressed in the form of graphs (a form of expression dear to the heart of every modern chemist.) Such methods would probably enable us to determine those qualities which we desire in bread and then to secure them in the best possible way even before the theoretical chemistry of bread baking was fully understood. Similiar tests could be made on sponge and pound cake.

When flour is not to be used in actual bread making I would most

strenuously urge that we avoid as far as possible, making a test by baking a yeast-raised loaf. By using yeast we introduce another important variable. We also have a test which is both slow and difficult to make accurately and which is almost impossible to duplicate in another laboratory. I can hardly think of a test where more depends on individual manipulation or which is harder to standardize than the bread baking test.

For flours which are not to be fermented I can highly recommend the test used by myself⁶ and by Davis⁵ which consists in making up a standard biscuits and baking it under standard conditions. Tho this test involves some care in the manipulation it is much quicker and much easier to standardize than a bread baking test. The finished biscuit can be tested for baking strength, crushing strength, spread, spring in the oven, color, elasticity, and as many other tests as you will. By varying one ingredient the measurements may be used to test any of the ingredients used in biscuit baking. For example by varying the shortening, the shortening power of different fats may be tested. By varying the flour, the effect of different flours may be accurately determined, similarly for the other ingredients. Rather remarkable accuracy is possible in carrying out these tests.

To sum up, many other industries in a condition similar to ours have found definite physical measurements on the finished products powerful aids in the making of rapid progress. This would probably be equally true in the baking industry. The value of this method has already been proved by tests of this kind made on unfermented biscuits.

Who will be the pioneer in extending these tests to other forms of baked goods!

Who will be the pioneer in extending these tests to other forms of baked goods?

5. Ind. Eng. Chem. 15 (1923) 390, Chem. Age, 30 (1922) 157, 203.

6. Ind. Eng. Chem. 13 (1921) 797.

The Bacteriology of Flour and Cereals: A Problem

By MARTIN DUPRAY, B. S., M. S.

Director, The Dupray Laboratory, Hutchinson, Kansas.

(Read Before the Kansas Millers Chemists Round Table, Wichita, Kansas,
July 28, 1923.)

I approach this subject rather from the viewpoint of the bacteriologist than the cereal chemist. But let me say that at the present time bacteriologists must also be chemists. We are now applying physiological chemistry and quantitative analysis to the study of bacterial physiology; we are controlling our culture media and processes by Hi-on concentration; and we are studying bacterial fermentations from the standpoint of the chemistry of the results.

Since bacteria were first discovered we have been learning that bacteria have a rather complicated physiology in spite of their small size. They have many enzymes for the purpose of making a wide variety of foods available to their organism, and for utilizing them in their organ-

ism, and the by-products and end products are varied. And each species has a distinctive physiology, at least in some details.

Perhaps in this discussion I should say microorganisms rather than bacteria, as many yeasts and molds, and forms intermediate between them and bacteria are of importance in the products considered.

Let us first take a general view of the subject.

There are enormous numbers of microorganisms of numerous varieties all around us. Fortunately only an extremely small percentage of the whole are pathogenic or harmful to us. They are largely harmless, and most of them, in the right circumstances are quite useful. The soil and the waters of the soil teem with numerous varieties of microorganisms of the kinds useful in their proper places, and the fertility of the soil depends in some measure on their fermentations. Since they are present in soil, those forms that can stand the necessary amount of drying will be found in dust.

When wheat is growing and ripening, soil is splashing up on the stems by rain drops, dust.

When wheat is growing and ripening, soil is splashed up on the stems by rain drops, dust is blown over the plants, and even the insects carry dirt on their feet. The germs contained in these materials grow and spread more or less over the wheat plants by growing in the dew that condenses on the plants at night, in the moisture from gentle rains and so on. As the glumes surrounding the grains harden and spread open more or less in ripening some of the microorganisms get on the grains before the wheat is harvested. The wheat is harvested and threshed and more dust and microorganisms are added and become distributed over the grains. In due time the grain is milled into flour and in this process the microorganisms are intimately distributed through the flour.

At this time we have several thousands or more of microorganisms per gram of flour. But of equal importance is the fact that there are numerous varieties of microorganisms present. There will be soil bacteria of the *Bac. subtilis* group, probably several species, spore forming bacteria digesting proteins with alkaline reaction, producing bitter tastes and marked odors from them, and not materially affecting starch; there will likely be a few anaerobic spore formers digesting proteins, with alkaline reaction, foul odors and bad tastes; there will likely be forms present capable of breaking down starch somewhat; there will be numerous lactic acid bacteria; there will be other forms of bacteria not here mentioned, and there will be wild yeasts probably of several varieties, and several varieties of molds. From the standpoint of biological fermentations the possibilities of most any kind are present.

Whether these various microorganisms or any of them will grow and multiply, whether they will carry out any of the possible fermentations and alter or damage the flour accordingly during storage, shipment or use, depends upon the conditions then and later.

Bacteria and other microorganisms demand certain conditions for growth, but the conditions demanded vary considerably with the species. A certain amount of moisture must be present; certain available food constituents; a certain oxygen supply; a certain H-ion range; a certain temperature range; but the minimum moisture requirement, the particular food elements demanded, the optimum oxygen supply, the optimum H-ion

range and the optimum temperature range will vary with the species.

Bacteria and the other microorganisms discussed here are plants. More than that, they are aquatic plants, they grow only in liquid. Molds it is true, send hyphae and fruiting stalks into the air from coatings over apparently dry surfaces, but their filaments go down to liquid, and they must have it to grow. Microorganisms take their food from the substances in solution in the liquid they are in, or from the solid substances bathed by the liquid and which the digestive enzymes of the microorganisms can put into solution.

At first thought it may seem far fetched to speak of microorganisms growing in flour and then state that they grow only in liquid, but the explanation is simple enough. The moisture in flour is present partly within the mass of the starch and protein, and partly as films around the particles. It is in these films of moisture that the microorganisms grow, if at all, and in speaking of the moisture requirements of bacteria growing in flour, it is the concentration of solution in these films of moisture that is of importance as far as the microorganisms are concerned, rather than the total moisture of the flour. A comparatively small increase in the total moisture of the flour may mean a considerable increase in the moisture in the film condition. Therefore a comparatively small increase in total moisture may make considerable bacterial growth possible when it was not possible before.

To return to our flour with its miscellaneous seeding with various microorganisms, if some of this be moistened and set aside, the character of the bacterial or mold spoilage taking place will depend on several things; the amount of moisture, access of air, and temperature being most important; with variations in composition of the flour itself being of secondary importance. In fact if one were to divide the sample into several portions and store each under different conditions, nearly as many different results would be obtained.

Let me illustrate this by an example from dairy bacteriology. Milk is another product that has a considerable seeding with numerous and varied species by the time it is delivered on the market. If a bottle of average market milk be divided into three portions, one kept just moderately cool, say 20°C, another kept in an incubator at body temperature, 37°C, and the third at 4°C to 5°C (this is colder than the average ice box, which is usually about 10°C) three distinct changes will occur.

The specimen kept cool but not cold, at about 20°C will sour and curd with what is called "sweet souring," the kind the cheese maker wants, with a strong acid reaction and a sour but not unpleasant taste or odor. This result is due to the growth of lactic acid bacteria which outgrow the other forms at this temperature, and as they grow, produce so much acid from the milk sugar that they either kill out or retard the growth of other forms that cannot stand the high acid reaction.

The specimen kept in the incubator at body temperature will sour and curd, but with very gassy curds and a foul, more or less fecal odor, and a very unpleasant taste. This is due to the growth of intestinal bacteria, of which *Bac. coli* will be the principle representative, because the temperature is their optimum and they outgrow other forms at this temperature. They ferment milk sugar with gas production and other substances present with production of decomposition products of foul or fecal odor and taste.

The third specimen of milk, kept at 4°C to 5°C will spoil very slowly, but will ultimately do so with an alkaline reaction and digestion of the protein, without curds or only flocculent ones, and with a putrid odor and bitter biting taste. This result is due to the growth of soil and putrefactive organisms which are the only ones present that can grow materially at the temperature, and which digest protein actively but do not ferment milk sugar.

I bring in this outside example of bacterial physiology partly because of the similarity of seeding of the products, and partly for the bacterial physiology itself to pave the way for an understanding of the relation of bacteriology to the different flavors, color and lightness of breads made in different ways from the same flour. Let us choose three more or less distinct examples here. And let me add that I am giving this as only one item influencing the quality of bread. There are many chemical and physical conditions entering into that subject.

In the old "salt rising" bread the housewife mixed a batter of the proper ingredients and set it aside to "work" over night, and with this as a starter made a dough which was followed to raise all day before being baked. No yeast was used, dependence being on the natural or wild yeasts in the flour. These yeast cells being present in rather small numbers it took them some time to get started in workable amount, and in the mean time numerous bacteria were growing. It would not always be the same varieties of bacteria, depending on temperature and other conditions, but some of the forms growing would digest gluten and other constituents with various decomposition products having various tastes and odors. The alteration in composition of the gluten would also affect its physical condition, color and behavior toward heat in the baking. I believe it safe to say that in salt rising bread there is more bacterial action than yeast action in the batter and dough, and that the resulting high flavor, dark color and graininess of the bread is in large part due to the bacterial decomposition.

Another method employed by housewives is to use a starter. This starter is originally made with baker's yeast. After getting it started a portion of batter or of dough is carried over from one baking to the next and used as a starter for the new batch. This method shortens the time of fermentation and raising over the previous method, but the amount of yeast carried over is still small in comparison with the amount of flour used, and the starter soon becomes seeded with numerous bacteria and other microorganisms besides the yeast. The fermentation and raising of the dough still involves considerable time and considerable bacterial action, and the result is a bread with a higher flavor, darker color and more graininess than baker's bread, but less than salt rising bread.

The third example is the modern baker's bread in which the dough is seeded with a large amount of pure yeast, the temperature and H-ion concentration are kept at the optimum for the yeast, the fermentation is soon over and the bacteria and other microorganisms in the flour never get a start. The result is a white fluffy loaf without the high flavors of bacterial decomposition.

Applying these same principles of bacterial physiology to flour in storage, realizing that the flour already has a more or less universal seeding with many varieties, one can easily see that the conditions of moisture, temperature and oxygen supply obtaining during storage, as well

as moisture at the time of storage, will determine whether there will be growth of microorganisms during storage, also the amount of the growth, the particular varieties that will grow, and the resulting chemical and physical changes in the flour.

The same arguments apply to the grain itself. Under certain adverse conditions bacterial changes may take place in the grain, either in the stack or bin, and these changes will be in addition to those incident to normal curing. The character and amount of the growth of microorganisms and the resulting changes will depend on the conditions obtaining; the amount of moisture in the grain at the time of stacking or storing, the temperature and weather at the time and later, the access of air, and on the amount of heating in stack or bin, if any.

From this point knowledge of the subject gets a little uncertain. Information regarding many details, such as the initial normal number of microorganisms in grain flour, the amount of increase under particular conditions, the specific changes wrought by many of the varieties present and the amount of bacterial or mold increase necessary to bring about deleterious changes, is rather fragmentary at the present time. In other words, normal starting points and danger limits are not yet very well defined.

The chief stumbling block to accurate knowledge of the subject is the absence of standard or reliable methods of determining the number of microorganisms in flour.

With most products in making bacterial counts it is customary to make appropriate dilutions with sterile water and plate these dilutions on an appropriate agar culture medium, incubate the necessary time and count the colonies that develop. This is the method commonly used for flour, but is inaccurate for reasons to be given.

With any product the plate colony count is not an accurate measure of the bacteria present but gives only relative results. The Committee on Standard Methods of the American Public Health Association, after several years comparisons of counts in milk, by the agar plate colony method and by the Breed direct microscopic method have concluded that the direct microscopic count shows about four times as many bacteria as does the plate colony count. Thus the colony count is only relative in value. This discrepancy has several causes: some of the microorganisms may be dead; some find the food substances of the standard culture medium unsuitable; some find the H-ion concentration of the medium unsuitable; some find the incubation temperature unsuitable; and many of the bacteria clump together in groups that do not break up by the shaking in making the plates. Such clumps or groups of bacteria give only one colony on the plate, whether the clump contains two germs or one hundred germs. The direct microscopic count shows all these germs that are dead or do not grow, or that give only one colony for many in a clump.

With the plate count on flour, all of these items causing incomplete plate colony counts are exaggerated. The varieties of microorganisms are more numerous and more varied. No culture medium chosen can satisfy all the forms present, nor can any one H-ion concentration, temperature, or oxygen pressure. Any method used will be arbitrary and will show in the resulting plates only those forms that will grow on the medium used and under the conditions of the test. It is necessary then to decide what forms of microorganisms occurring in flour are most likely to cause deleterious

changes and which ones we are most interested in, and choose a medium and conditions optimum for these varieties. It is doubtful if we have sufficient information on the subject to do this at the present time.

Another exaggerated source of error in plate counts of flour is the difficulty of getting accurate dilutions. Flour does not go into solution in the diluting water but forms a suspension. Each particle in the suspension becomes a nucleus for bacteria to adhere to and form clumps on, and this trouble is increased by the gluten softening up and becoming sticky. Each such clump or particle coated with microorganisms gives only one colony in the plates, regardless of the number of germs in the clump. As far as the bacteria are concerned this trouble cannot be avoided as in milk by the direct microscopic count because the starch and particles render this impossible on the bacteria, though it is possible to make fairly reliable counts of yeast cells and mold on flour directly with the microscope.

In the absence of more satisfactory methods we cannot at the present time expect laboratories to check results on bacterial counts in flour. Any given laboratory, using always the same method, can check its own results within certain wide limits, and its results will have a certain definite relative value, but if the same product be tested in different laboratories, probably using somewhat different culture medium, conditions and methods, we cannot expect their results to check more than very approximately.

It is doubtful if in the present state of our knowledge of the bacteriology of flour and cereals, we are ready to establish either initial normal counts on good flour, or danger limits. Neither can we do this until reliable standard methods have been established. It is probable in choosing methods that we will need to use two or three culture media and sets of conditions simultaneously to get the information we need.

The general principles underlying this subject are understood. Detailed knowledge is fragmentary, and standard methods should be established. I highly recommend this phase of cereal bacteriology for investigation, in the firm belief that much information may be gained by it that will be useful both to the miller and the baker.

Protein Content vs. Texture vs. Kernel Weight in Southwestern Market-Run Hard Winter Wheat

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This is the second of a series of papers dealing with protein content and texture and kernel weight of wheat. The first paper¹ presented at last year's meeting of the A. A. C. C., was confined to Hard Red Spring Wheat. Other papers are contemplated on pure types of Southwestern Soft Red Winter Wheat from wheat nurseries in Texas, and on Commercial Mixtures of Market-Run Southwestern Wheats.

The relation of protein content to physical characters if of special

1. Reference is to literature cited at the end of this paper.

interest to the grain dealer and to the miller. Most of us (chemists) have heard a miller remark,—“That protein report on our bakers flour is too low. It was made from straight Dark Hard Winter Wheat. You had better run your test again.” Some of us have heard a grain dealer complain,—“Your protein report on ear----is too low. That ear graded No. 1 Dark Hard Winter, 62 pounds test. Run that protein test over and phone me your result.” Often the dissenting party will mention instances where “lower grades,” or “ordinary hard wheat” ran higher in protein. It is this condition of affairs that is responsible for much of the present dissatisfaction with the protein test. Persons (not chemists) are attempting to estimate or anticipate protein content of wheat. Failure to do so results in complaints against the protein test. The protein test is condemned because in many instances, the physical characters of the grain have been misinterpreted.

The object of the investigation reported herein was to determine the relation, if any, of certain physical characters of the kernels to protein content. Texture, and the size or weight per thousand kernels, also grade, test weight and color or general appearance will be considered. Each sample represents a ear of 1922 crop wheat received at this market.

Protein Content vs. Texture.

Protein content of the “dark hard and vitreous” and the “not dark hard and vitreous” (yellow) kernels in each of forty-four (44) samples was determined. The results are summarized in Table No. 1. The average, maximum, minimum and range in protein content is given for both the yellow and the dark hard portions.

Table No. I.
Protein Content for “Yellow” and “Dark Hard” Portions of 44 Samples
of Hard Red Winter Wheat.

	Yellow	Dark Hard
Average protein content	10.68	12.37
Maximum protein content	13.40	14.04
Minimum protein content	9.36	11.08
Range in protein content	4.04	2.96

An interesting comparison is afforded by Table No. 1. Nineteen of the yellow portions contained more protein than the average of all the dark hard portions, i. e., more than 12.37%. The range in protein content of all of the yellow portions was 4.04 percent and of the dark hard portions 2.96 percent. The difference between the maximum protein content of both groups is 0.64 per cent, and between the minimum protein content of the two groups is 1.72 percent. That is, the range in protein content is greater within a given group of portions, than between either the maxima or the minima of both groups. The maximum difference in protein content between yellow and dark hard portions of the same sample, was 3.60 percent, and the minimum was 0.44 percent. In every case the dark hard portion contained more protein than the corresponding yellow portion from the same sample.

From the data given and the facts cited in connection with Table No. 1, I am led to believe that the selection of hard winter wheat contain-

ing a high average percent of dark hard and vitreous kernels will provide a milling mixture of wheat containing slightly more than the average amount of protein. This statement applies only to averages based on a considerable number of ears, and not to individual ears.

It would appear that any statement concerning texture and protein must be qualified by saying that within a given sample the darker, harder, and more vitreous kernels contain relatively more protein, but that the yellow kernels in one sample may contain more protein than the darkest, hardest and most vitreous kernels in another sample. If this fact was fully appreciated by the grain dealer and the miller who do not determine protein by chemical methods but depend on guess work many of the discussions over protein content would be avoided.

Conclusions.

1. Within a given sample the dark, hard and vitreous kernels contain more protein than the yellow kernels.

. Taking a large number of ears, those containing a high average percent of dark kernels will contain a relatively larger amount of protein than other ears containing a lower average percent of dark hard and vitreous kernels.

(Note: Geographic, soil, and climatic conditions assumed to be uniform.)

Protein Content vs. Kernel Weight

The samples were arranged progressively according to the kernel weight of the original sample. For convenience, the samples have been divided into four groups of eleven samples each. The average kernel weight of the original samples and of the yellow and dark hard portions have been tabulated. The protein content of the yellow and dark hard portions are given in Table No. 2.

Table No. 2
Average Protein Content and Kernel Weight of Yellow and of Dark Hard Portions of Four Groups of Eleven Samples Each.

Group No.	Average Kernel Wt. Per M. of Original Sample	Average Protein Content Yellow Portions	Average Kernel Wt. Per M. of Yellow Portions	Average Protein Content Dark Hard Portions	Average Kernel Wt. Per M. of Dark Hard Portions
1	21.03	10.34	21.08	11.96	19.69
2	22.02	10.85	22.96	12.49	21.71
3	24.36	10.71	23.94	12.35	24.16
4	26.80	10.79	26.42	12.64	26.52
Av.	23.55	10.68	23.60	12.37	23.02

From the data presented in Table No. 2, there does not appear to be any marked relation between kernel weight and protein content of the yellow portions of the samples analyzed. In the case of the dark hard portions, there seems to be a direct and progressive relation between average kernel weight and protein content. It should also be mentioned, that in the first three groups the difference in protein content between the respective yellow and dark hard portions remains practically constant, while the av-

erage kernel weight of the dark hard portions increases and the difference in kernel weight between the yellow and dark hard portions decreases. These observations conflict with the generally accepted opinion that an increase in kernel weight is usually accompanied by a decrease in protein content. For a very patent reason, no conclusions will be drawn from the data in Table 2, as the author intends to continue the study on this phase of the texture problem.

Protein Content vs. Test Weight

The samples have been tabulated according to test weight in Table No. 3, and the protein content of the yellow and dark hard portions are given as most of the cars graded No. 2 or better, this data does not include a sufficient number of the lighter test cars to warrant drawing conclusions relative to test weight.

Table No. 3
Protein Content of Yellow and Dark Hard Portions Arranged Progressively According to Test Weight.

Group	No. of Samples	Test Weight		Protein Content	
		Average Lbs.	Range Lbs.	Yellow Per Ct.	Dark Hard Per Ct.
1	1	53.	53.	10.80	11.56
2	2	57.2	57.-57.3	10.30	11.68
3	9	58.3	58.-58.9	11.05	12.43
4	15	59.2	59.-59.8	10.59	12.41
5	14	60.2	60.-60.7	10.53	12.15
6	3	61.0	61	10.80	12.66

In general the same statement applies to test weight as was made for kernel weight, namely: test weight has no appreciable effect on the protein content of the yellow portions, but the protein content of the dark hard portions increases with higher test weights.

Protein Content vs. Grade

In as much as test weight was the principal grading factor (weevils excepted), the same general statement applies as in the case of test weight.

Protein Content vs. Color.

A majority of the samples were slightly bleached, three or four badly bleached and three or four were bright, but the number of samples is believed to be too small to justify any statement on this point. It is evident from the data at hand, that the effect of bleaching is greatly overshadowed by other factors, except in extreme cases where protein content may run unusually high or the reverse. In some instances, bleaching changes the texture, or at least conceals a once dark hard and vitreous texture.

The following extracts from an unpublished report² dealing with the 1921 crop of hard Red Winter wheat, is included here as showing the results obtained on that crop.

In order to test the efficacy of the present d. h. and v. kernel in selecting high protein cars of wheat, the data has been arranged in Table

No. 3 to show the number of "hits" and "misses." Midway points between the average percentages of d. h. and v. as given in Table No. 2-B, have been taken as the intermediate limits for the respective groups.

(Note: See Table 3.)

Table No. 4

The Efficacy of the Percent of Dark Hard and Vitreous Kernels in Selecting High Protein Cars of Wheat.

Percent of Dark Hard and Vitreous Kernels		Total Numbers of Cars in Group	Protein Content					
Range	Corresponding to Protein Content		"Hits"	Number of "Misses"		All Cars In Group	"Misses"	
				High	Low		High	Low
80.0-100	14.00 and up	4	1	none	3	13.67	none	13.56
75.1-79.0	14.00 and up	5	none	none	5	12.62	none	12.62
77.8-75.0	13.00 to 13.99	6	1	none	5	12.39	none	12.27
60.2-67.7	12.00 to 12.99	15	11	3	1	12.47	13.33	11.40
50.0-60.1	11.00 to 11.99	20	6	14	none	12.10	12.40	

The ranges in percentage of dark, hard and vitreous kernels to all practical purposes may be considered to be as follows:

1st group	80% and over
2nd group	76% to 80%
3rd group	70% to 75%
4th group	61% to 69%
5th group	60% and less

Table no. 3 points to some very radical conclusions, aside from those already given. Had the miller binned all of the 50 cars according to the percent of d. h. and v. he would have been correct just 38 percent of the time. In the case of "Near Dark Hard" with 67 to 79% d. h. and v., he would have been correct only 9 percent of the time, and most of his worst "misses" would have occurred in the groups containing d. h. and v. in excess of 67%. In the "ordinary" Hard Winter containing not over 60% d. h. and v. he would have missed on 7 out of every 10 cars.

Conceding that what is lost in the high percent d. h. and v. cars, would be made up in the low per cent d. h. and v., we must conclude that it would have been just as well—if not a little better—to mass the 50 cars in one bin, than to attempt to bin them according to the percent of d. h. and v. Excluding those cars grading Dark Hard, we find a maximum range of one half of one percent between the average protein content of the several groups. The maximum range between cars in the same group is six times that amount.

Summary

- 1st. There is no constant relation between percent d. h. and v. kernels and protein content.
- 2nd. In the absence of protein determinations, it is better to mass all hard winter wheat from a protein standpoint than to bin it according to percent d. h. and v.
- 3rd. There is greater variation in protein content within a given group than between the averages of different groups, using the

percent d. h. and v. as the basis of classification."

Continuing the quotation from the conclusions given at the end of the previously mentioned paper:—

- "1st. Color or general appearance, and the percent of Dark Hard and Vitreous kernels, either alone or in combination, are of very little value in selecting individual lots of high protein wheat.
- 2nd. Color or general appearance, and the percent of Dark Hard and Vitreous kernels, either alone or in combination, preferably in combination, may be of limited value in selecting high protein lots of wheat when many selections are made and mixed together as composite lots.
- 3rd. Some ordinary Hard Winter wheat contains more protein than some Dark Hard Winter Wheat. Approximately 25 percent of Market Run Hard Red Winter wheat grading 60 to 80 percent dark hard and vitreous carried at least 13.00 percent protein.
- 4th. "Gluten" (protein) tests enable the miller to substitute ordinary hard winter wheat high in protein content for Dark Hard winter, and so reduce the amount of Dark Hard winter required for blending.
- 5th. There is nothing to indicate to what extent the conditions under which "bleaching" occurred, has influenced the protein content of wheat as compared with unbleached wheat from identically the same source. There is reason to believe that "bleaching" may decrease the percent of Dark Hard and vitreous kernels, and that it may also affect the protein content.

(Laboratory experiments not reported are the basis for the above statements.)

- 6th. The protein content of individual lots of wheat is more or less independent of both color or general appearance and the percent of Dark Hard and Vitreous kernels present. There is a definite tho small correlation when large numbers are considered."

Conclusions.

1. Protein content in Hard Winter Wheat cannot be estimated with any degree of accuracy. The man, whether he be a grain dealer or a miller, who employs a bookkeeper to keep his books, a stenographer to write his letters, a traffic man to look after the rates, routings and tonnage of his shipments and receipts, and then leaves the selection and classification of his hard milling wheat to guess work, is not consistent in his business methods.

2. It is possible to obtain a slightly higher average protein content by selecting those cars carrying a relatively high percent of dark hard and vitreous kernels. However, it is much more economical to run protein on all cars (market run) and select the high protein cars. In this way a uniform protein content can be maintained in blends and mixtures, and a higher protein content can be obtained when desired for special blends. The principal advantage in this method is in the premiums saved on the dark hard cars. The disadvantages of using only dark hard cars are:—1st, the premium; second, the uncertainty of getting a high protein content; and

third, the variable protein content which tends to make a non-uniform product.

Literature Cited.

1. Frank, W. L., "Texture Classification of Wheat," Jour. Amer. Ass'n. of Cereal Chemists, Vol. VII., Oct. 1922, No. 4, pages 174 to 181.
2. Frank, W. L., An unpublished report "Quantitative Comparison of the Percent of Dark Hard and Vitreous vs. Protein Content," dated Dec. 5, 1921.

Moisture Determinations

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The determination of moisture in cereal products though apparently a simple procedure of drying a weighed sample to constant weight in an air, hydrogen, or vacuum oven, or some sort of desiccator, presents certain difficulties which have caused wide discrepancies in the results of collaborators. Upon reviewing the reports of investigators we see no agreement in either the methods or results of the various collaborators. Each chemist finds his particular method giving satisfactory relative results in daily routine work, but learns that his results do not check with other analysts on the same sample in comparative reports.

There are many reasons why these moisture results do not check as we find them tabulated by various investigators in the bulletins of the A. O. A. C., the American Institute of Baking and the A. A. C. C. The type of oven used, the kind of dish, open or covered, the time of drying, the degree of vacuum, the temperature, the charge in oven, or a combination of these factors, all affect the final moisture results obtained.

One point upon which all investigators agree, I believe, is that the vacuum oven gives higher average results than the air or water oven. Frank T. Shutt, D. Sc. and P. J. Moloney, M. A., in a paper read in 1917 before the Royal Society of Canada conclude that, "Lower results obtained by heating flours to constant weight in an air oven at 100°C as compared with those from drying in a vacuum oven at the same temperature, are not due to oxidation of the flour. They point rather to incomplete drying." In the co-operative work carried on by the American Institute of Baking in 1920, and published in their bulletin No. 2, we find that the results of collaborators using vacuum methods averaged .44, .35, and .28% higher respectively, on the three samples, than results of those using air ovens. Mr. L. E. Leatherock reported last year that in comparing the results on his check sample, the vacuum ovens gave an average result .3% higher than the air ovens. Mr. M. E. Schulz also found last year that the chemists using vacuum ovens reported higher results on a sample which was sent out to 12 different laboratories. In Mr. Harry Snyder's pamphlet on "Wheat Flour, its Weight and Moisture Content," he contends that the moisture as determined by the vacuum method runs about 1% higher

than results obtained by the water-bath oven. In a comparison made in our own laboratory between the vacuum oven at 100°C and the air oven at same temperature upon a great number of samples it has been found that the variation always ranged from .1% to .3%, the vacuum oven invariably giving the higher results.

One other factor in moisture work upon which I believe most chemists agree is that the dishes used must have close-fitting covers which must be put on as soon as the sample is taken from the oven. The official method of the A. O. A. C. and approved method of the A. A. C. C. specify covered dishes. In order to satisfy ourselves of the importance of this factor, a comparison was made using covered and uncovered moisture dishes. Five grams of the same sample of flour were weighed into four cylindrical aluminum dishes $2\frac{1}{2}$ inches in diameter and $\frac{3}{4}$ inches high and the samples were dried in an air oven at 105°C for four hours. Two of the dishes had close-fitting covers, and these covers were put on as the samples were taken from the oven. The two uncovered samples were cooled in the desiccator along with the other two samples. After cooling to the temperature of the laboratory, the following moisture results were obtained:

Samples in Covered Dishes	Samples in Uncovered Dishes
13.59%	13.34%
13.61%	13.39%

In order to determine whether this gain in weight of the uncovered samples was taken on in the desiccator, or on the balance pan, another sample of flour was weighed into four dishes and dried in an air oven at 105°C for four hours. Two of the samples were covered as they came from the oven and cooled in the desiccator, the other two were cooled uncovered in the desiccator. However, in weighing the uncovered dishes the sample was placed under an inverted crystallizing dish which was ground to fit a glass plate. By thus excluding the air from the sample on the balance, the following comparison was obtained:

Covered samples	Cooled uncovered, but covered on balance
13.27%	13.11%
13.25%	13.06%

.24% lower average results were therefore obtained by cooling and weighing dishes uncovered, and .18% by cooling in desiccator uncovered but weighing covered. This seems to prove that the higher results of the uncovered samples is due to gain in weight partly in the desiccator and partly on the balance pan.

This same experiment upon closed and open dishes was tried using the vacuum oven at 100°C for drying the samples. Following are some of the comparative results on various samples of flour:

Covered dishes	Uncovered dishes
14.44%	14.24%
14.18%	14.00%
14.42%	14.20%
14.36%	14.00%

Average of results of the uncovered samples is therefore .24% lower than the covered.

To determine if even the covered samples gain in weight by absorption of moisture, eight 5-gram samples, four covered and four uncovered, were put back in the desiccator after the first weighing and allowed to stand for one hour. At the end of this time the samples were quickly weighed again and it was found: that the average gain of the covered samples was .0013 grams or .026% moisture.

That the average gain of uncovered samples was .0161 grams or .322% moisture.

It is therefore evident that the open or uncovered dishes are not suitable for moisture work, as the dry flour seems to be even a better desiccating agent than Calcium Chloride. In all further work, therefore cylindrical aluminum dishes two and one-half inches in diameter and three-quarters inches high with close-fitting covers were used.

Another fact not quite as generally known, or at least not as much mentioned, is the slow heating in the inside chamber of the vacuum oven when the oven is quite well filled with samples. A small Fahrenheit thermometer was placed inside the chamber of the vacuum oven, and by holding a light up to the mica panels at intervals, the temperature was noted. Fifteen 10-gram samples (150 grams flour) were placed in the oven. The thermometer above the chamber read 212°F. The following data was obtained:

Time After Closing Vacuum Door	Temperature Inner Thermometer F°.	Vacuum Inches
closing door -----	134° -----	0
5 minutes -----	142° -----	12
10 minutes -----	146° -----	6
95 minutes -----	184° -----	27
110 minutes -----	186° -----	27
135 minutes -----	191° -----	27
160 minutes -----	193° -----	27.2
175 minutes -----	195° -----	27.2
200 minutes -----	198° -----	27.4

Thus it is evident that the inner chamber was still 14 degrees cooler than the temperature of the oven as read on the regular thermometer, 3 hours and 20 minutes after putting in the samples. This slow heating up of the samples can be accounted for by the continual evaporation of the moisture and the poor conduction of heat in a vacuum.

The time required for complete drying in the vacuum oven at 100°C, of five 5-gram samples (25 gram total charge) was determined and the following figures obtained on the same sample of flour using covered aluminum dishes. The samples remaining from the first determination were not put back in the vacuum but another set weighed out for each time period.

	½ hr.	1 hr.	1½ hr.	2 hr. ½	2½ hr.	3 hr.	5 hr.
	11.13	13.17	13.80	13.98	14.09	14.21	14.22
	11.17	13.17	13.76	13.96	14.05	14.22	14.18
	10.91	13.17	13.79	13.94	14.04	14.18	14.20
	11.34	13.16	13.76	13.94	14.04	14.14	14.21
	11.25	13.14	13.69	13.98	14.05	14.17	14.23
Average	11.16	13.16	13.76	13.96	14.05	14.18	14.21

It was decided that 3 hours in the vacuum oven was sufficient for 25 grams at 100°C, as 5 hours only increased the average moisture .03%.

To prove that a high degree of vacuum must be maintained air was admitted into the chamber keeping the vacuum at from 10 to 15 inches. Five grams of the same sample of flour were weighed into five covered dishes (25 grams of flour, total charge) oven at 100°C:

13.85%
13.85
13.87
13.86
13.86

Average, 13.86%

After drying to constant weight, our previous result upon this same flour was found to be 14.18%, and our average result is now 13.86%.

Thus it is evident that a lowering of the degree of vacuum affects the drying, as the same results are not obtained as with full vacuum.

Next the effect of varying the temperature of the oven was tried up to 100°C. Five 5-gram samples of the same flour were used. Covered dishes, 3 hours time, about 27.5 inches vacuum.

50°C	75°C	90°C	100°C
11.55%	13.68%	14.02%	14.20%
11.45%	13.72%	14.01%	14.19%
11.37%	13.71%	14.00%	14.18%
11.35%	13.69%	14.03%	14.17%
11.33%	13.68%	14.00%	14.16%
Average, 11.41%	13.70%	14.01%	14.18%

It was found that complete drying was not possible using the same time, degree of vacuum and charge in oven, with a lower temperature. Of course, by varying any of the other constants, time, vacuum, or charge, a lower temperature than 100°C might have given satisfactory results.

The next consideration was the charge in the oven, that is, the total number of grams of flour dried in the vacuo. In previous investigations of the effect of time, temperature, and degree of vacuum, five 5-gram samples of flour were used as the total charge. Following results were obtained on the same sample of flour using 1, 2, 3, 5 and 8, five-gram portions as total charge in oven at one time:

1-5 gm	2-5 gm	3-5 gm	5-5 gm	8-5 gm
14.28	14.27	14.33	14.34	14.16
	14.34	14.37	14.34	14.12
		14.28	14.34	14.20
			14.34	14.18
			14.32	14.14
				14.18
				14.16
				14.15
Average, 14.28	14.30	14.33	14.34	14.16

From above it is noted that there is a decrease in moisture content when the total charge is more than five 5-gram samples.

205 grams total charge flour was placed in the vacuum for 3 hours at 100°C and about 28 inches vacuum obtained. The five-gram samples included in this charge averaged only 12.86% moisture or 1.32% below the actual moisture as previously determined on this flour. These samples were all again placed in the vacuum for 3 hours additional time when the five samples averaged 13.88% moisture, still .3% below the correct figure.

It was decided to find the time required for 150 grams flour total charge using the same temperature and degree of vacuum as before. Five 5-gram samples of another flour were weighed into the five aluminum dishes and enough other samples to make a total charge of 150 grams. The samples were taken out, cooled and weighed at the end of four hours, and then put back in the vacuum and re-weighed at intervals. The following are average results on the five samples of the same flour at end of certain periods.

4 hrs	5 hrs	6 hrs	7 hrs	9 hrs	11 hrs	14 hrs
11.30	11.42	11.46	11.45	11.58	11.56	11.58

Thus it is evident that it would take about 7-9 hours to get the samples to constant weight and thus obtain correct moisture results with 150 grams total charge in vacuum. Therefore in using the vacuum oven in routine work running from 20 to 25 5-gram samples at 100°C, it would take more than 3 hours to get correct results, and the time required is thus dependent upon the charge in the oven. A rule which seems to be safe to follow is,—a minimum time of 4 hours in the vacuum oven for 30 grams of flour or less as the total charge—then for every 30 grams of flour, or portion thereof over 30 grams, add one hour to the time required. This requirement of more time for greater charge is no doubt due to the fact that the moisture given off from a greater number of samples hinders quick and complete drying by checking the temperature and degree of vacuum inside the chamber.

A combination of air and vacuum drying was next tried. A sample which had been dried in the vacuum oven to constant weight was found to contain 11.60% moisture in duplicate determinations according to the official method of the A. O. A. C. Five 5-gram samples of this same

sample of flour were used in each test. The dishes were placed first in an electric constant temperature air drying oven, and then transferred hot to the vacuum oven. The combinations of temperature and time were as follows. The moisture as given is the average of the five results in each set:

Air Oven		Vacuum Oven	Moisture
1 hr.	95°C	plus 2½ hrs. 120°C	11.48%
1 hr.	104°C	plus 2 hrs. 120°C	11.51%
2 hrs.	103°C	plus 1 hr. 120°C	11.36%
2 hrs.	107°C	plus 2½ hrs. 120°C	11.58%
1 hr.	120°C	plus 2 hrs. 120°C	11.54%
2 hrs.	120°C	plus 2 hrs. 120°C	11.48%
1 hr.	140°C	plus 1 hr. 140°C	11.58%

As one hour in air at 140°C plus one hour in vacuum at 140°C gave results in the shortest time, checking with the official A. O. A. C. method, therefore, a great many tests were made using this combination method. The charge was increased to 24-10-gram samples and it was found that the results checked with those obtained using the official method. As it was found that 10-gram samples could be used, and also as many as necessary to fill the vacuum oven, the torsion balance was tried for weighing the samples. A balance was employed weighing to .005 gram. Weighing on this balance was found satisfactory for regular routine work as the variation due to error in weighing would not exceed .1% of moisture.

It might be argued that 140°C would tend to decompose the flour or cereal being dried. However, we find upon referring to an article published in the Journal of Industrial and Engineering Chemistry of January 1920, pps. 40-45, by O. A. Nelson and G. A. Hulett, that such is not the case. Quoting from the article mentioned, "The moisture-temperature curves indicate to us the amount of moisture liberated at each temperature and the break shows the point of temperature at which decomposition becomes measurable when the sample is heated for 3 hours or more. One point of importance to be noted about the moisture temperature curves is that none show any distinct breaks before a temperature of 184°C is reached and with the exception of wheat flour and protein, the deviation from a straight line is very slight until 218°C is reached." The entire article by O. A. Nelson and G. A. Hulett throws much interesting light on the decomposition of cereals at higher temperatures.

That higher temperatures than that of boiling water can be used advantageously in the determination of moisture in cereals has been suggested by previous authors. Arthur Fornet says in *Z. Nahr. Genussm.* p. 329-32 (1916) as abstracted in *Chemical Abstracts* (1917) p. 505. "The ordinary method of estimating moisture by heating the substance to constant weight in a water oven is untrustworthy, for a substance so dried will undergo a further loss of weight if the temperature of the oven is raised. A method for the estimation of moisture in flour is described consisting of heating substance on the pan of a lever balance placed in an air oven at 170°C."

F. T. Birchard says in *Jour. Soc. Chem. Ind.* 263-5T (1918) as abstracted in *Chem. Abst.* p. 2630 (1918) that "the amount of water in wheat cannot be determined by simply drying in an open oven or vacuum at a definite temperature to constant weight or until an increase in weight.

The loss in weight at a high temperature cannot be obtained at a lower temperature and longer time."

In the co-operative work done by the American Institute of Baking in 1920 as outlined in Bulletin 2, Jan. 1921, the results by use of vacuum and air ovens were commented on thus: "The results from the use of air ovens by drying in air at various temperatures are more variable than with vacuum methods and greater deviations from the mean are shown." The summary of air drying at various temperatures was then inserted. Following this: "The above differences are much greater than with the vacuum methods and results are not as concordant among themselves. The elimination of non-uniform air-drying methods seems demanded by these results, and the adoption of drying in vacuo according to a standard procedure such as that of the A. O. A. C. is recommended. Nelson and Hulett have shown that decomposition is extremely slight when wheat flour is heated to 100-115°C in a very high vacuum for 4-6 hours, and that in fact, there is very little increase in the water due to decomposition even when the temperature is raised to 180-184°C. A rapid method of moisture determination should be studied based on the use of a high temperature and vacuum according to Nelson and Hulett. The use of such a method would result in a great saving of time which is consumed by the usual methods of moisture determination."

From the above it appears that other investigators have found the higher temperatures satisfactory and sometimes necessary. At 140°C decomposition is not rapid enough to cause any loss in weight due to anything but the water present. We know that some moisture is still retained by cereal substances as colloidal and absorbed water at 100°C in an air oven. At 140°C the greater portion is driven off and especially when a vacuum oven is used to complete the drying.

It is certain that a vacuum oven is necessary to carry off the last traces of moisture in cereals as in a vacuum the water vapor is drawn off as it is formed. In an air oven as long as considerable moisture still exists in the sample it is given off as fast as the sample acquires the heat of the oven. However, as the vapor pressure continually drops with the loss of the greater part of the moisture, the system gets to a point where no water is given off although some moisture may still be present.

However, if the vacuum oven is used alone in determining moisture, certain difficulties are encountered. If only a few samples are used and these are small samples of from 2-5 grams, it does not require an unduly long time to get the samples to constant weight. From our investigation we have found that 3 hours at 100°C is sufficient for five 5-gram samples. On the other hand, when the total charge in the vacuum oven is increased to from 100 to 250 grams of flour, it takes such a long time to get the samples to constant weight, that for routine laboratory work the results are obtained too late for doing the most good.

We have also found how slowly the samples heat in the vacuum oven. When samples are placed cold in the vacuum we found it took over 3 hours before the inner chamber approached within 15 degrees F of the outside temperature of the chamber using a 150 gram charge. In an air oven on the other hand, currents are set up which quickly drive away the most of the moisture, and the samples attain the heat of the oven in much less time than in a vacuum.

By drying the samples first in the air oven at a high but safe temperature, the most of the moisture is driven off in the shortest possible time. By weighing the samples after removal from the air oven, we have found that from 95 to 99% of the total moisture is driven off in one hour in the air oven maintained at 140°C. The most of the moisture is therefore eliminated in the air oven where it passes out without doing any damage. If large charges are run in the vacuum oven using a vacuum pump with the regular oil seal, the water is carried down into the oil fouling it quickly and necessitating changing the oil frequently. After preliminary drying in an air oven, the samples go into the vacuum nearly dry and very little moisture collects in the vacuum pump. The samples are also already of the same temperature as the oven so that the vacuum rapidly rises and the final drying commences immediately. We have found that one hour in the air oven maintained at 140° plus one hour in the vacuum at the same temperature will bring the samples to constant weight, and the moisture results obtained will check results obtained by the official method of the A. O. A. C. The time required for a determination on an oven full of samples is therefore two hours plus the time required for weighing in the samples, cooling the samples after removal from the vacuum, and the final weighing. By using a good torsion balance sensitive to .005 gram the samples can be weighed in rapidly, minimizing the error due to drying of the samples on the balance pan of a more sensitive analytical balance. By using a 10 gram sample in a covered aluminum dish about 2½ inches in diameter and ½ to 1 inch high, this torsion balance will weigh accurately enough for results within .1% which is usually close enough for routine work.

There may be other combinations of the air and vacuum ovens using different temperatures, and varying in time in either oven, but we have found 1 hour air at 140°C plus one hr. vacuum at 140°C very satisfactory. This suggested method may not be of any value as far as a standardization of moisture methods among chemists is concerned, but it does offer a rapid accurate method for determining moisture in routine cereal laboratory work. By checking results at intervals with the Official Method, it should be both safe and sane.

Relation of Bakery and Mill Laboratories

By ROWLAND J. CLARK

Goerz Milling Co., Newton, Kansas.

The transformation of wheat from the farmer's field to toast on the family breakfast table interlocks two of the most important industries represented in the membership of the AMERICAN ASSOCIATION OF CEREAL CHEMISTS. The time when the Baker ground his own flour is past, not because there was no profit in such an enterprise, but because the modern trend is toward specialization. The baker and the miller, therefore, are going their respective ways, each building up his industry in his own way; but each not only related to but dependent on the other. The flour mill must sell the baker flour or cease to grind wheat. The baker

must buy flour or cease to bake bread. Hence the manufactured product of the one becomes the raw material of the other.

During the natural advances of these industries certain ideals have been maintained by each as goals, the achievement of which means perfection. These ideals are today paramount in the discussions whenever either are gathered in convention. Each miller is trying: first to make a better flour than his competitor, second, to maintain the uniformity of this extra quality flour, and third reduce the cost of milling to a minimum. The accomplishment of anyone of these ideals spells success, and the realization of all three not only means return orders and guaranteed satisfaction, but places a mill upon a firm foundation. Each baker is striving, first, to manufacture a better loaf of bread than his competitor, second, having established this standard loaf, to maintain its quality from day to day, and third, to bake this loaf as cheaply as possible. The public is sometimes a peculiar critic causing the miller or baker to deviate from his desired standard, but in short these facts express the objects of each industry.

Considering the two industries in question, one is selling, the other is buying. Each wants protection in its transactions. The baker wants to know if the flour is of good quality in order to make a product superior to his competitor, if it is uniform so that he can maintain this product and therefore, if it is worth the quoted price. The miller wants to know precisely the same fundamental points in order to establish a selling price. The baker wants protection in buying, the miller protection in selling. The result is each submits the product to a laboratory for inspection. Thus it is that the cereal laboratory becomes the referee upon any point in question.

The bakery laboratory establishes by analysis and research the loaf of bread desired and maintains the established standard by analysis of raw materials. Analytical control becomes an important function of such a laboratory. The requirement that all raw products meet set specified standards removes guess work. The milling laboratory establishes its standard and by routine control holds the flour uniform. The findings of these laboratories are often the basis of contention, hence like the referee of a foot ball game the reports and decisions must be based on facts, not hearsay or suppositions. These laboratories must understand each other, therefore exhibit in common the following qualities:—(1) Honesty, (2) Accuracy, (3) Standardized methods, (4) Uniform methods of reporting.

One of the first lessons which a chemist learns is that of honesty. Without this quality a scientific man cannot hope to succeed. The daily work is with facts and any distortion leads to confusion. Never should a milling laboratory be placed under the supervision of the head miller because, first, not having a scientific training, the miller has little conception of the chemist's work, and second, there should be no temptation placed before the chemist to report an ash or protein just to suit the miller, or give figures other than those actually found. Never should a bakery laboratory be placed under the baking superintendent because the chemist should be unhampered and free to report his true findings. Both laboratories belong on equal footing and their chemists on equal ground with the millers and baking superintendents reporting and responsible only to their respective managers. Working in co-operation *with* the millers and

superintendents not for them will lead the chemist to feel that honest results secure and not jeopardize his position.

Accuracy is a quality learned by constant practice. Laboratory reputations are founded upon accuracy in minor details because it is the close attention to the best technique which enables a laboratory to render true reports. When a baking laboratory is given a report from a mill, much distrust of the report is removed, if it is known that the report originated in a place noted for careful work. Reliance and dependability are easily built up on accuracy.

The employment of standardized methods in mill and bakery laboratories is absolutely essential. There is a right and wrong way of performing any piece of work. These methods are not the product of some one fanatical mind, and, therefore, not worthy of consideration; but they are the outgrowth of many minds and much experimental evidence collected and condensed to point out to inexperienced manipulators the experience of pioneers. The writer has visited laboratories, where flour moisture pans were not covered on being removed from the drying ovens, but were weighed uncovered, where kjeldahl flasks were heated so hot in protein digestion that a large amount of ammonia produced was volatilized and lost (yet this laboratory boasted upon its remarkable speed in protein determinations) and where bread baking was a farce. Never can a mill laboratory co-operate with, or hope to agree with a bakery laboratory until both employ standard methods of analysis. The time when a flour mill chemist could run moisture, protein and ash determinations according to his own peculiar ideas is past, because his baker customer may attempt to check the results. It is a lamentable fact that so many various methods are employed by members of our association not only in reporting baking results but in the baking itself. Recommendations have been made (and adopted by the larger laboratories) with regard to baking formulas, fermenting temperatures, time of fermentation, pan size, etc., but many laboratories refuse to be governed by rules or even suggestions. It is a noticeable fact that the laboratories which have established reputations for reliable work, where chemists of standing are employed and where flour brokers are anxious to obtain first hand information on new crops, are the laboratories which adhere to the tentative and approved methods of the Association. Standardized methods such as are being worked out by our Association form the interlocking basis between cereal laboratories and tend to eliminate petty differences between chemists.

It has been aptly said that an analyst is worth \$100.00 a month, that an analyst who can explain the analysis after making it is worth \$200.00 a month, but that an analyst who explains and can apply the information gained is priceless. This bit of philosophy is absolute truth. The most important task of the laboratory is the interpretation and application of the analysis. A laboratory may have been honest in reporting the results reached through accurate work in following standard methods, but fail in making the report.

Uniform methods of reporting will help toward removing many misunderstandings in the interpretation of results. The universal adoption of reporting ash and protein on 13.5% moisture basis will give the mill laboratory a basis upon which to figure with the bakery laboratory. Specifications made by the bakery including such a standard will remove

possibility of uncertainty when the flour mills fill the order. It might be well to call to mind the fact that when a government order for flour is filled, there is no uncertainty regarding ash, moisture and protein specifications.

Every laboratory has its own peculiar laboratory report form giving the information which it obtains and regards as important. Very few reports ever give the findings in a way which would enable a stranger, unacquainted with the methods of that laboratory, to obtain an understanding of the analysis, much less compare it with the report from another laboratory. For instance, many reports give the volume of a loaf of bread in cubic inches or cubic centimeters, but they omit the scaling weight of the dough. They fail to mention whether the grain was close and even or open and coarse, that the fermenting time was too long or too short, as judged by the finished loaf, what ingredients were used, and many other factors which modify their volume. What a step forward would be taken if our Association could adopt a standard form containing the essential items collected on each flour analysis to be practical enough for daily laboratory use, and not used only on special occasions!

An industrial chemist in order to be a personal success must possess salesmanship qualities. Never can a chemist either in a mill or bakery laboratory hope to ever lift himself above routine analysis, till he can catch a glimpse of the importance of the laboratory, how it can be of service to the purchasing as well as the selling and manufacturing departments; and can convince his manager of his absolute scientific need. In short the chemist must, just as a salesman, sell himself and with himself his goods. Volumes might be written upon this characteristic in a chemist, but time does not permit such a discussion at present. Any means which will establish closer co-operation between bakery and mill laboratories will aid in the chemists better standing with his organization. For instance, how confusing it is for a mill laboratory to send a flour sample to a bakery laboratory for testing, and receive a report giving moisture, ash and protein on the flour as received. These figures probably do not check those obtained when the flour was sent out until reductions to a common moisture basis are made. Explanations have to be made to the manager, who, if he be hasty, jumps to the conclusion that laboratories are bunk, because they cannot check. He hesitates, and rightfully so, to spend money on an apparently uncertain project, so the chemist is ever fearful of his standing. Confidence in the laboratory is shaken. Although the moisture basis is the point here considered, uniformity in baking reports is just as essential.

The application of a report is a very important item, if a mill laboratory hopes to place in the bakery laboratory, not only flour but service which will sell the flour. When a mill receives a bakery report giving a set standard which must be met by the flour, the chemist must interpret and then apply the information given. These specifications have been given for some time among the laboratories, but it presupposes awaiting the baker's inclination to buy. To stimulate business and urge the baker to buy reverse the process, by having the mill chemist visit the baker and by inspection of the shop, recommend the grade of flour best suited for that bakery. Then the first flour shipped will produce results, there will be a satisfied customer, and repeat orders will follow. The mill chemist must

know baking as well as milling and wheat growing, if he is to be a true asset to the mill. The mill laboratory then begins to function and attract attention on the credit side of the ledger.

More and more industries are beginning to realize that, to have satisfied customers, the consumer must be instructed just how to obtain the best results from the product sold. Thus the yeast companies are not content by selling yeast, they instruct the bakers in bread making; and the fruit growers associations depend not upon the grocers selling their oranges, lemons and raisins, but they advertise to create the demand among the consumers. How many flour mills tell the housewife the merits of bread and have technical departments whose duties are helping the bakers and giving service along with or in precedence of the flour delivery?

There are various kinds of service. Frequently a mill having a laboratory sells to a small baker who has no laboratory. If the mill is honest this baker is protected just as much in his flour purchase as he would be had he a modern equipped laboratory. The bakery with a laboratory can likewise render a service to the flour mill having no laboratory by giving a true report upon the flour received. This is service which promotes business and is a credit to any laboratory.

In sharp contrast to this fair dealing, let another viewpoint be considered. Science has for ages been considered by the layman as mysterious and frequently the scientist is regarded as a magician or person of super human powers. Unscrupulous mills use their laboratories as tools and play upon the ignorance of the small baker. He in time learns of the misrepresentation finds he was duped by a wily mill loses faith and forever condemns the laboratory and all its men. This baker's business is lost to the mill forever. The crooked baker may secure a biased report from his laboratory, and thereupon base a claim for adjustment. Should the mill learn of the deception distrust will be ever stamped on the baker. At present both the bakery and mill laboratories are talking hydrogen ion and viscosity. These are not new ideas in science, but their application in industry is new. Many interpretations of the principles involved in such determinations and rosy possibilities which the future holds are appearing in our trade magazines by authors who evidently understand journalism better than chemistry. The capitalization of sound scientific principles based upon facts and knowledge is legitimate, and tends to strengthen the bond between the mill and bakery laboratory; but deception cloaked under laboratory figures destroys business.

In conclusion it should be remembered that both a mill and bakery laboratory if functioning in accordance with the ideals of their respective industries will so interlock their interests that their chemists can speak on common terms. These laboratories should be careful; first, to give honest reports, second, to do accurate work, third, to follow standardized methods, fourth, to interpret correctly by means of uniform reports, and lastly to apply the reports which involves giving the best possible service. The operation of these principles will boost the mill and bakery. Therefore, the relation of the mill and bakery laboratories following these truths will be one of complete co-operation.

The Effect of Chemical Leavening Agents on the Properties of Bread

By FLORENCE C. SMITH and C. H. BAILEY¹

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The ancient civilization of Egypt and Rome employed yeast as a leavening agent in the production of yeast leavened bread. It was not until comparatively recent times that chemical leavening agents were used to replace yeast. Luke Wright (cited from Hart, 1914) obtained the first patent for aereated bread in England in 1832. Dr. Dauglish (cited from Crampton, 1899, and Hart, 1914) of England in 1856 (Crampton, 1899, gives the date as 1859) introduced the method which bears his name. In this process the water to be used for the bread was charged with carbon dioxide, in a closed vessel under forty pounds pressure, and later this solution is mixed under pressure with the flour. After the dough was mixed, panned, and immediately placed in the oven, it rose, due to the expansion of the gas. Later this process was modified by the addition of a weak wort, for which malt and flour were mashed together and allowed to ferment. It was found that the acid liquid resulting absorbed the carbon dioxide readily. The product was somewhat tasteless, for the flavor characteristic of yeast bread was lacking. This process had the advantage however that there was no danger of improper fermentation.

History of Baking Powders

Baking powder was used in England about 1830 (cited by Hart, 1914.) It was made of pearlash and alum; later with sesqui-carbonate of ammonia.

Baron Liebig, the German chemist, discussed the subject, and suggested the rise of hydrochloric acid as the acid component, in mixture with sodium bicarbonate. Dr. Whiting used this reaction in his first patent obtained in 1837. Sodium bicarbonate has generally been used as the source of the carbon dioxide, but considerable study has been given to the problem of finding a suitable substance for the acid component. Horsford, in 1864, patented the first acid phosphate powder. Having been a former student of Liebig's he persuaded Liebig to introduce and manufacture it in Germany. Hoaglands, druggists in Fort Wayne, Indiana, originated the cream of tarter baking powder in 1868, and later founded the Royal Baking Powder Company. In 1880 alum baking powder was put on the market, and in 1892 the so-called "S. A. S." or sodium aluminum sulfate baking powders appeared, which now replace the alum powders.

Baking Powder Standards.

The following definition of baking powder was promulgated in 1918 by the Secretary of Agriculture under the United States Food and Drugs Act,—"*Baking powder* is the leavening agent produced by the mixing of an acid reacting material and sodium bicarbonate with or without starch

1. Published with the approval of the Director as Paper No.-----, Journal Series, Minnesota Agricultural Experiment Station.

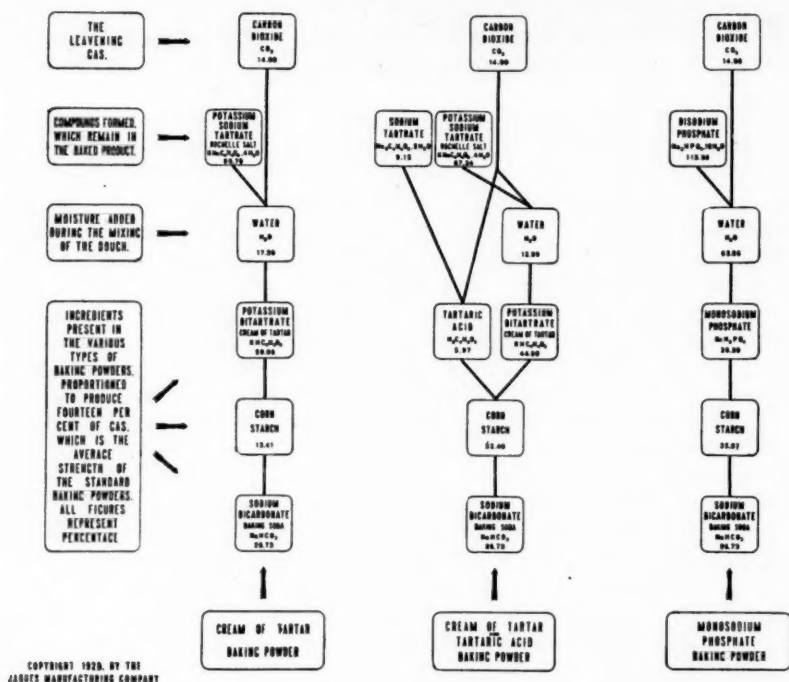
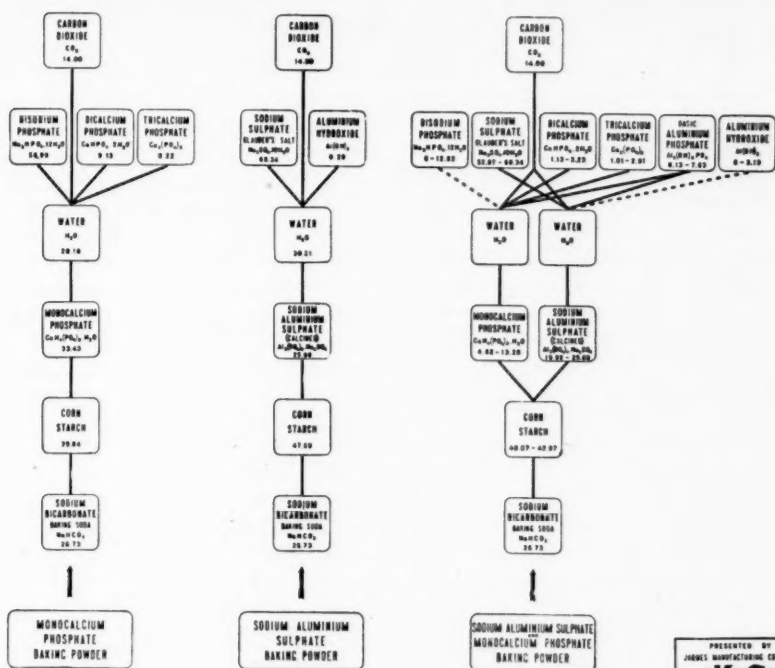


Figure 1—Graphic baking powder chart by Chittick showing

or flour." All baking powders accordingly contain sodium bicarbonate, and it is the only alkali or source of leavening recognized by the United States standard, according to the definition (cited from Chittick, 1923.) Substances that have in the past been used with or substituted for sodium bicarbonate are magnesium, potassium, and ammonium carbonates (cited from Hart, 1914.) Magnesium carbonate is a cheap alkali to use, but it is more bulky than soda and slower in its action. The bitter residue left by potassium carbonate caused its rejection. Ammonium carbonate has been used alone sometimes, for it leaves no residue if completely decomposed, but the odor is not always completely dissipated in baking certain classes of products.

There are various factors influencing the choice of the acid and the baking powders are classified according to the kind that is used. The factors influencing the acid component used which are enumerated by Hart (1914) are cost, the ease of obtaining it, its aerating value, its keeping qualities and the character of its residue. The acid reacting materials in baking powders recognized according to the United States standard are,—“(1) tartaric acid or its acid salts, (2) acid salts of phosphoric acid, (3) compounds of aluminum, or (4) any combination in substantial proportions of the foregoing” (Food Inspection Decision No. 174, February 26, 1918.) Cream of tartar or potassium bitartrate is the acid reacting material in tartrate baking powders. This is the most expensive baking powder and it has been partially replaced by the cheaper types, but its keeping qualities are good and it aerates the dough well (cited from Hart,



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of the different types of baking powders.

the reactions

1914.) Tartaric acid is a by-product in the manufacture of cream of tartar (potassium bitartrate) and this is now quite universally used with cream of tartar, making a combination cream of tartar and tartaric acid baking powder. The objections (cited from Hart, 1914) to the use of tartaric acid as the sole acid ingredient are that the action is too rapid, the action being complete with the use of cold water alone, and it has poor keeping qualities. In the phosphate baking powders, monocalcium phosphate is usually used. This is cheaper than cream of tartar, reacts somewhat more slowly in the dough, but is difficult to keep unless it is properly protected, owing to its hygroscopicity (Hart, 1914.) Monosodium phosphate has been used to a limited extent. A fourth type of acid ingredient involves the use of aluminum salts, of which potassium and ammonium alum were the first used in the manufacture of these powders, being sold under the trade name of "C. A. S." (Cream of tartar substitute.) In 1892 the so-called "S. A. S." baking powder appeared in which sodium aluminum sulfate was used. This is now used to the exclusion of the common alum, either alone or in combination with a phosphate, the combination being made usually with monocalcium phosphate.

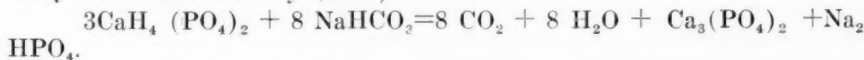
In each baking powder we find a diluent, either starch or flour, which is used to prevent the acid and the alkali from reacting in the presence of hygroscopic moisture. Cornstarch having a neutral reaction and containing not more than 5 to 10% moisture is commonly used. The quantity used commercially varies, depending upon the acid ingredient in the powder.

Chemical Reactions

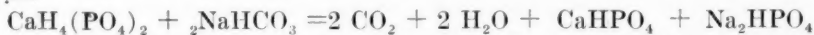
There is some conflict of opinion regarding the course of the chemical reaction resulting when different chemicals in these powders react in aqueous solution. Chittick (1923) in his graphic chart (Figure 1) has divided the baking powders into six classes and indicates the reaction in each case. In this chart the necessary proportions of each ingredient are indicated to produce a powder yielding 14 per cent of carbon dioxide in each case.

It will be noted that the residue left following the reaction of the constituents of a baking powder varies according to the materials and the proportions used. The kind and quantity of residue, resulting from the reaction in the case of cream of tartar, combination of cream of tartar and tartaric acid baking powder, monosodium phosphate, and sodium aluminum sulfate baking powders, have been determined with reasonable accuracy. Residues from monocalcium phosphate, and combination sodium aluminum sulfate and monocalcium phosphate baking powders are a little questionable as yet. Difficulty has been experienced in titrating the phosphoric acid or the calcium phosphates and the results have not been satisfactory nor in all cases have they been explained. Wadman (1921) found when titrating to neutrality the calcium acid phosphates, that an intermediate product resulted which was between mono and tricalcium phosphate. This he believed was dicalcium phosphate. Wendt and Clarke (1923) have recognized the difficulty in the ordinary titration methods. They followed the changes occurring during the neutralization process of titration by electrometric methods of titration and have overcome many of the other difficulties. They indicate that dicalcium phosphate is a transitory product in changing from a monocalcium phosphate to a tricalcium phosphate and that it is not found in the equilibrium mixture. Tricalcium phosphate was found to have a pH value of 8.5, while monocalcium phosphate is acid and has a pH value of 4.0. These workers further state that the course of the reaction and the end-products vary with the type of alkaline component.

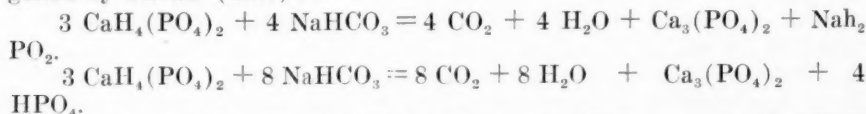
The following is the reaction as given by Hart (1914) and referred to by Davis and Maveety (1922):—



Leach (1913), quoted by Davis and Maveety (1922), gives this reaction:—



Davis and Maveety (1922) compare these reactions with that suggested by Patten (1917):—



It seems to be agreed that with the use of a larger amount of sodium bicarbonate, disodium phosphate rather than monosodium phosphate is formed, and in most cases it is agreed that tricalcium phosphate is formed as the phosphate in the residue. The formation of these different phos-

phates, including the transitory dicalcium phosphate, accounts for the difficulty in determining the neutralizing value of the monocalcium phosphate component of baking powder. Chittick (1923) indicates in the chart (Figure 1) that if there is an excess proportionately of the monocalcium phosphate in the combination sodium aluminum sulfate and monocalcium phosphate baking powder (as 1.0 part $\text{CaH}_4(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$ to 3.457569 parts of $\text{Al}_2(\text{SO}_4)_3 \cdot \text{Na}_2\text{SO}_4$), then disodium phosphate is formed with sodium sulfate, dicalcium phosphate, tricalcium phosphate, and basic aluminum phosphate, but no aluminum hydroxide appears. If however there is more sodium aluminum sulfate present in proportion to the monocalcium phosphate, then no sodium phosphate is formed with the sodium sulfate, dicalcium phosphate, then no sodium phosphate is formed with the sodium sulfate, dicalcium phosphate, tricalcium phosphate and basic aluminum phosphate, but aluminum hydroxide is formed.

Effect of the Residual Salts on the Properties of Flour.

The work on baking powders has heretofore been concerned chiefly with analytical procedure, and particularly the determination of the quantity of carbon dioxide evolved. Little attention has been given to their effect on the flour with which they are always used. In the studies reported in this paper an effort was made to ascertain the effect of the different residual salts, particularly the soluble salts resulting from the reaction of various baking powders on the properties of flour. For this purpose several experiments were conducted, including (a) mixing the soluble residual salts with the flour and noting their effect when washing the gluters; (b) washing out the gluten in the customary manner and then immersing it, after the method of Wood's (1907) experiments, in the salt solutions for twenty-four hours; (c) determining the hydrogen ion concentration of doughs and biscuit prepared with baking powders or the residual salts, and (d) testing doughs so treated with the Chopin apparatus.

Quantity of Salts Used.

The quantity of residual salts to use with a given amount of flour was calculated on the basis of the proportion of baking powder found in a baking powder biscuit mixture. The proportions were those previously used in a series of baking experiments in these laboratories, and are as follows:

Table 1.
Proportions for Baking Powder Biscuit Dough.

Ingredients	Ounces	Grams	Per Cent
Salt	8.00	226.8	83.78
Baking powder	0.42	12.0	4.43
Salt	0.12	3.5	1.29
Fat	1.00	28.4	10.50

Water 160 cc. or 65-70% of weight of flour used.

The baking powder used was equivalent to 5.287 grams per 100 grams of flour. Using the data given in Chittick's chart, the quantities of the sev-

eral residual salts in doughs containing this proportion of baking powder were then calculated. These computed amounts are given in Table 2.

Table 2.
The Calculated Quantity of Residual Salts Found, Following the Reaction of 5.287 Grams of Baking Powder When Used in a Dough with 100 Grams of Flour.

	Residue	Grams of Residue Per 100 Grams Flour
Cream of tartar	Rochelle salt ($\text{KNaC}_4\text{H}_4\text{O}_6$)	4.75
	or $\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	6.78
Cream of tartar and tartaric acid	Sodium tartrate ($\text{Na}_2\text{C}_4\text{H}_4\text{O}_6$) plus Rochelle salts ($\text{KNaC}_4\text{H}_4\text{O}_6$) or $\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$	0.48 3.56 0.57
	$\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	4.78
		6.03
Monosodium phosphate	Disodium phosphate (Na_2HPO_4) or $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$	6.03 15.19
Sodium aluminum sulfate	Sodium sulfate (Na_2SO_4) or $\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$	3.62 7.03

Effect on Gluten of Mixing the Residual Salts with the Flour.

In the experiments to determine the effect of the residual salts on the flour, 25 grams of soft winter wheat flour were used with the proportionate quantity of the salts. The flour was weighed on a triple beam balance, while the salts were weighed on an analytical balance since in some cases small quantities were required. Ordinary tap water was used since that is usual in ordinary household baking in which baking powders are employed. A control of flour and water only, was used as a check in each series of tests. All experiments were carried out in duplicate.

In preparing the dough, the flour and the residual salts, whenever the latter were to be used, were mixed in a porcelain bowl or mortar and 15 cc. of water added to this mixture. The method followed is essentially the quantitative method given by the Association of Official Agricultural Chemists for the determination of gluten. Each dough was timed accurately and received identically the same treatment.

When standing immersed in water, all the doughs appeared the same, —soft and spongy. There were, however, considerable differences in the behavior of the gluten mass during the washing operation. The control gluten was elastic and coherent throughout the process, and tough after the treatment. The gluten obtained from the dough containing disodium phosphate lost most of its elasticity and cohesiveness during this treatment and was difficult to wash without losing a large part of the gluten with the starch. After the pieces of gluten began to cohere, it was easier to wash away the starch and to form the gluten into a compact mass. The gluten remaining is tough and friable.

It was no so difficult to obtain the crude gluten from the remaining doughs. The doughs containing potassium sodium tartrate and potassium

sodium tartrate plus sodium tartrate resembled the control closely in ease of washing a little if any gluten was lost during this process. The gluten from the dough containing potassium-sodium tartrate plus sodium tartrate was a little less elastic than the one containing potassium tartrate alone. The gluten from the dough containing potassium-sodium tartrate was somewhat more elastic than the gluten from the dough containing disodium phosphate, but it does not possess the tensile strength of the control. The gluten from the dough containing potassium-sodium tartrate plus sodium tartrate has less tensile strength than the one with potassium-sodium tartrate alone. The gluten ball is not, however, as resilient as the control.

The dough containing the sodium sulfate remains the most elastic of all those containing these salts, though less than the control, and can be stretched a considerable distance before breaking. Very little gluten is lost in washing out the starch and it remains coherent.

Thus it is observed that the disodium phosphate affects the gluten most, tending to keep it from forming a tough, firm, compact mass. A certain measure of hydration of the gluten, such as is observed in the use of this salt, may be advantageous in imparting a degree of friability and shortness to biscuit. In view, however, of the large proportion of the salt which results from the use of a monosodium phosphate powder with a 14 per cent gas strength, the concentration of the soluble residual salt may be too great. The consequence is an alkaline dough, and biscuit, in which hydration of the gluten has been carried too far.

Effect of Immersing Gluten in the Residual Salt Solutions.

In this series of experiments, the procedure was similar to that employed by Wood (1907) in studying the strength of flour. Beakers of 250 cc. capacity were selected and glass rods bent into a V-shape suspended in such a way that the point of the V reached half way to the bottom of the beaker and the ends of the rods rested on the sides of the beaker. Glutens were prepared in the same manner as in the previous controls, and immersed in solutions of the several residual salts, the salt solutions having the concentrations shown in Table 3. In calculating the concentration of these salt solutions it was assumed that the residual salts in a dough containing the corresponding baking powder were dissolved in the water of the dough. The concentrations shown in Table 3 accordingly are based upon the ratios of salts to flour shown in Table 2, and the absorption of the flour. At room temperature the disodium phosphate and sodium sulfate would not dissolve completely in the concentrations shown here, and hence saturated solutions were employed in these cases.

Table 3—Residual Salts Used per 100 cc. of Water.

Residual Salts	Grams
Rochelle Salts ($\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$)	9.82
Sodium Tartrate ($\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$)	0.88
plus	
Rochelle Salts $\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	7.35
Disodium Phosphates ($\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$)	23.37
Sodium Sulfate (Na_2SO_4)	5.57

The pieces of gluten were placed on the V-shaped rods and hung in these solutions so as to be completely immersed. For a control tap water was used in the same manner as the salt solutions. Each beaker was covered with toluene and allowed to stand twenty-four hours in order to reach equilibrium conditions, being carefully timed during the entire treatment.

In no case did the gluten hydrate more than the control and the solutions remained clear except in the case of the disodium phosphate which was slightly opalescent. Disintegration of the gluten did not occur. The glutes in the water, and potassium sodium tartrates solution became a little elongated, while the gluten in the potassium sodium tartrate plus sodium tartrate solution, and in the sodium sulfate solution contracted into a round mass, while that in the disodium phosphate solution contracted even more decidedly. All remains resilient and elastic, but less so than the control. The gluten which was immersed in the disodium phosphate solution was the least elastic of the series. In spite of the relatively high hydroxyl ion concentration of this solution, as shown in Table 4, no pronounced dispersion of the gluten immersed in it resulted, due, no doubt, to the high concentration of the salt in solution.

Hydrogen Ion Determinations

The hydrogen ion concentration was determined, both of the doughs used in the first experiments and of the solutions in the second. In Table 4 is shown (a) hydrogen ion concentration (as pH) of the doughs in which tap water was used; (b) the hydrogen ion concentrations of the salt solutions made with tap water; and (c) those of the salt solutions prepared with distilled water.

Table 4

Hydrogen Ion Concentration (as pH) of the Doughs Containing the Residual Salts and of the Salt Solutions.

Control	Rochelle Salt	Rochelle Salt Plus Sodium Tartrate	Disodium Phosphate	Sodium Sulfate
(a) DOUGHS CONTAINING RESIDUAL SALTS				
7.58	7.41	7.32	7.48	7.38
(b) SALT SOLUTIONS MADE WITH TAP WATER				
	7.40	7.52	8.76	7.57
(c) SALT SOLUTIONS MADE WITH DISTILLED WATER				
	7.00	6.73	8.77	7.05

Thus it was found the use of tap water affected the hydrogen ion concentration considerably, except in the case of the disodium phosphate, which was heavily buffered. The potassium-sodium tartrate plus sodium tartrate solution was slightly acid in distilled water while in tap water it was slightly alkaline. The other two salt solutions were neutral in distilled water. The extreme alkalinity of the disodium phosphate accounts for much of its action on the gluten, and a substantial effect on the baked product might be anticipated.

Water Imbibing Capacity of Glutens in Residual Salt Solutions

As a measure of the effect of these residual salts, the moisture content

of the gluten was determined, and a comparison made to ascertain whether or not the salts tended to modify its water imbibing capacity. The glutes which had been immersed for twenty-four hours in the salt solutions were weighed and then dried in a vacuum oven at 100°C., and their moisture content calculated. From these data, the quantity of water in grams imbibed per gram of dry was computed, and these computations are given in Table 5.

The salts tended to reduce the water imbibing capacity of the gluten, disodium phosphate being the most effective.

Table 5
Water in Grams Imbibed per Gram of Dry Gluten After immersion
in Various Salt Solutions.

Control	Rochelle Salt	Rochelle Salt Plus Sodium Tartrate	Disodium Phosphate	Sodium Sulfate
2.09	1.54	1.53	1.38	1.51

Tests of Doughs with the Chopin Extensimeter

The Chopin extensimeter is designed to determine the elasticity and extensibility of dough, there being apparently a correlation between these properties of a dough and its baking properties. Doughs were prepared with 300 grams of flour and 180 cc. of a 2 ½% sodium chloride solution. Using this simple dough as a control, residual salts and the corresponding baking powders were superimposed individually upon the formula in order to observe and compare the effect of the residual salts, and baking powders. Two commercial samples were purchased, Royal, a cream of tartar plus tartrate acid powder, and Ryzon, a disodium phosphate powder. Four baking powders, namely cream of tartar, monocalcium phosphate, sodium aluminum sulfate, and sodium aluminum sulfate plus monocalcium phosphate, each with a 14 per cent gas strength, were prepared by Dr. Chittick and furnished for these tests. The same proportions of baking powder and the residual salts to flour were used as in the other experiments. Doughs were mixed in a mechanical machine for a period of eight minutes. After removing the dough from the mixer it was pressed lightly into a sheet about one inch in thickness, brushed with Mazola Oil, and covered with a wet cloth. After twenty minutes it was cut into biscuit shaped discs for the tests. These biscuits were then compressed into a thin sheet in the extensimeter, after which the dough sheet was inflated like a huge bubble. The size of these bubbles was determined, and the data in the tabulation is expressed as the square root of the volume. The average results of ten replicate measurements are recorded in Table 6. It was found that the consistency of the doughs varied a great deal, some being very difficult to handle, and the effect of the residual salts varied widely from the effect of the baking powders. The doughs made with residual salts in each case were soft, sticky and hard to handle, as contrasted with the control. In addition to the residual salts, sodium aluminum sulfate was used in one test as an example of an ingredient of a baking powder in which one of the residual products would be aluminum hydroxide. This was done to note its effect on the dough, though it was one of the components rather than a residue of the baking powder with which it is associated. The consistency of the resulting dough was better than that in

which the residual salts were used. This was probably due to the effect of the aluminum ions which tend to increase the coherence of gluten. The doughs containing the baking powders were normal in consistency, except when sodium aluminum sulfate baking powder was used, in which case the dough was abnormally stiff.

Table 6
Extensibility of Dough Determined by the Chopin Extensimeter.

Control	Rochelle Salt	Cream of Tartar Baking Powder	Rochelle Salt Plus Sodium Tartrate	Royal Baking Powder
21.79	8.33	15.28	12.47	15.93
Disodium Phosphate		Ryzon Baking Powder	Monocalcium Phosphate Baking Powder	
9.32		16.32	21.56	
Sodium Sulfate	Sodium Aluminum Sulfate	Sodium Aluminum Sulfate Baking Powder	Sodium Aluminum Sulphate Monocalcium Phosphate Baking Powder	
9.57	14.21	14.43	17.83	

From the values recorded in Table 6 it is evident that there was considerable variation in the effect of the various residual salts and of the corresponding baking powders. This is doubtless in part due to the fact that under the conditions of the experiment the reaction of the baking powder was incomplete. We were accordingly dealing with the components of the baking powders rather than the residual salts and the former are not as pronounced in their action on the dough as are the corresponding residual salts. That residual salts of baking powders do affect the dough, and cause it to lose much of its extensibility, is evident from these results.

The Chopin extensimeter is well suited to studies of this kind. Further reference will be made to its construction, and field of usefulness in a later paper from this laboratory.

Baking Experiments

A series of biscuit baking experiments were conducted with several commercial baking powders, namely Rumford, Calumet, Royal, Ryzon, and K. C., as well as with the type powders furnished by Dr. Chittick.

The proportions of ingredients in the biscuit doughs were noted above, except that with the lot of soft wheat flour used, a dough of good consistency was produced through the use of 140 cc. of water. Experiments were conducted with tap water and distilled water. The flour, baking powder and salt were mixed together in the mechanical mixer for about one minute, and then the fat was added and the mixing continued about five minutes. The dry mixture was placed in a bowl and cold water was stirred in with a spatula. The biscuits were baked in an electric oven at a temperature of 255-260 degrees C. for twelve minutes. One series was baked without any baking powder to serve as a control or basis of comparison.

In determining the hydrogen ion concentration 31.8 grams of the biscuits (equivalent to 20 grams of flour) were broken into small fragments, and shaken up with 100 cc. of water. The results of these determinations, expressed as pH, are given in Table 7.

Table 7
The Hydrogen Ion Concentration (as pH) of the Baking Powder Biscuits

Baking Powder	Hydrogen Ion Concentration as pH
Biscuits Made with Tap Water	
K C	7.44
Calumet	7.48
Royal	6.85
Ryzon	7.32
Rumford	7.31
Cream of Tartar	5.84
Monocalcium Phosphate	7.76
Sodium Aluminum Sulfate	6.55
Sodium Aluminum Sulfate plus Monocalcium Phosphate	6.57
Biscuits Made with Distilled Water	
"Control" without Baking Powder	5.64
Ryzon	7.30
Cream of Tartar	5.74
Monocalcium Phosphate	7.24
Sodium Aluminum Sulfate	6.95
Sodium Aluminum Sulfate plus Monocalcium Phosphate	6.53

Biscuits made with cream of tartar, or a cream of tartar plus tartaric acid powder (Royal), have a hydrogen ion concentration on the acid side of neutrality. The same is true of the sodium-aluminum sulfate and the sodium-aluminum sulfate plus monocalcium phosphate baking powder biscuits. The phosphate powder biscuits were slightly alkaline.

The acidity of the combination sodium aluminum sulfate and monocalcium baking powder is probably due to the presence of some monocalcium phosphate; for either the reaction was not completed so that all of the monocalcium phosphate was converted to tricalcium phosphate; or more monocalcium phosphate is present than could be neutralized by the alkali.

All the baking powders used diminished the acidity of the mixture with flour, although to varying degrees. This is evident from the fact that in every instance biscuit made with baking powder had a higher pH than the "control" biscuit made with flour and water alone.

The authors wish to acknowledge the advice and aid of Dr. J. R. Chittick, of the Jaques Manufacturing Co. Dr. Chittick permitted the use of his chart illustrating the course of the reaction in the solution of various types of baking powders, and also furnished samples of standard types of baking powders for use in the experimental work.

Summary

Gluten properties, including elasticity and hydration capacity, are

affected by baking powder, and by the residual salts resulting from the chemical reaction of baking powder ingredients.

Disodium phosphate, the residual salt resulting from the reaction of monosodium phosphate baking powder affects gluten more than the residual salts from other types of baking powder. This residual salt is likewise present in an ordinary biscuit dough in the largest proportions.

Extensibility of a dough, as measured with the Chopin extensimeter, is diminished appreciably by the several baking powders used in these experiments, and is reduced even more by the residual salts of the same baking powders.

Hydrogen ion concentration of biscuits made with these baking powders is reduced, when compared with control biscuits made without baking powder. The decrease in hydrogen ion concentration is greatest when monosodium phosphate baking powder is used in the usual proportions, and the resulting biscuit are distinctly on the alkaline side of neutrality.

Literature Cited

- Chittick, J. R.
1923 a. A volumetric method and apparatus for determining the carbon dioxide content of baking powders. Pamphlet, privately printed.
1923 b. Graphic baking powder chart. Published by the Jacques Mfg. Co.
- Chopin, Marcel
1921. Relation entre les propriétés mécaniques des pâtes de farine et la panification. Extrait du Bull. de Mars. 1921, Société d'Encouragement pour l'Industrie Nationale, p. 261-273.
- Crampton, C. A.
1899. Foods and food adulteration. U. S. Dept. of Agr., Bur. Chem Bul. No. 13, part 5, p. 561-624.
- Hart, R. W.
1914. Leavening agents. Chem. Pub. Co., Easton, Pa. (Literature cited p. 51-68; 69-74.)
- Wadman, W. E.
1921. The determination of "strength" or neutralizing power of acid calcium phosphates. Jour. Ind. Eng. Chem., v. 13, p. 1146-1148.
- Wendt, G L., and Clarke, A. H.
1923. An electrometric study of the neutralization of phosphoric acid by calcium hydroxide. Jour. Amer. Chem. Soc'y., v. 45, No. 4, p. 881-887.
- Wood, T. B.
1907. Chemistry of strength of wheat flour. Jour. Agr. Sci., v. 2, p. 267-277.

Ninth Annual Convention, June 4-9, 1923

Hotel Sherman, Chicago.

Monday Morning, June 4th

Registration of members and visitors.

Monday Afternoon, June 4th

Meeting called to order at 2:00 P. M. by Pres. Lawellin. A. A. Jones, Sec.-Treas., was unable to be present--R. K. Durham appointed acting Sec.-Treas.

Reading of communications.—Letter from the National Conference Committee of Baking Industry regarding "Eat More Wheat Campaign" referred to M. E. Schultz. Letter from San Francisco inviting A. A. C. C. to hold their next convention in that city. Letter from National Wheat Conference. Pres. Lawellin suggests A. A. C. C. send a delegate. Letter from W. W. Hatten, England, asking that he be billed on for five years dues as associate member.

President requests pleasure of the Convention regarding banquet. Motion by Wood that A. A. C. C. hold banquet Thursday night. Seconded. Warren moves amendment that Tuesday or Wednesday night be substituted. Lost for want of a second. Original motion carried. J. C. Wood and A. A. Heon appointed on committee to make arrangements for banquet. President cautions Methods Committee to be prepared to make report Wednesday morning. Warren moves a nominating committee be appointed. Seconded. Carried. Motion by Warren that nominating committee be appointed by the President. Seconded. Carried.

President appoints on nominating committee: M. E. Schultz, M. R. Warren and L. H. Bailey.

Committee appointed by President to acquaint millers and chemists: L. R. Olsen, H. F. Vaupel and Ralph Morgan.

Motion by Hess that committee be appointed to formulate policy, method of editing and other matters pertaining to the Journal of A. A. C. C. Seconded, carried. Articles of amalgamation of A. S. M. B. T. and A. A. C. C. as signed March 28, 1923, read by President.

Motion by Hess that Journal Committee consist of three members to be appointed by the chair. Seconded, carried. Committee as appointed:—J. R. Hess, C. H. Bailey and C. J. Patterson. Wood moves each Society audit its own books. Lost for want of a second. Schultz moves that President appoint a committee consisting of two members from each Society to amalgamate and examine the records of A. S. M. B. T. and A. A. C. C. Seconded. Hess moves motion be amended to read that members be elected. Schultz withdraws motion. Second consents.

Motion by Schultz that two members from each Society be elected to audit the books. Seconded. Lentz amends motion to make committee appointive instead of elective. Seconded. Carried. Motion as amended carried. President appoints on this committee:—Hess, Rainey, Ferrari and Grey. President appoints resolution committee composed of Heon and Wood. Wood moves adjournment. Lost for want of a second. Each mem-

ber called upon to rise and introduce himself. Motion to adjourn seconded, carried.

Tuesday Morning, June 5th, 1923

Meeting called to order 9:20 A. M. by Pres. Lawellin.

Paper—"Has Northwestern Wheat Deteriorated?" by C. H. Briggs, Howard Laboratories, Minneapolis, Minn. (Mr. Briggs was unable to be present and paper read by Secretary.

Paper—"Recent Investigations on Durum Wheat Conducted at the North Dakota Experiment Station" by Prof. C. E. Mangels, North Dakota Agricultural College.

Wood moves that no picture be taken of the Convention as a group. Seconded, carried.

Lantern talk—"The Use of the Viscosimeter in Flour Strength Studies," by Dr. C. H. Bailey, University of Minn.

Paper—"The Action of Shortening," by Washington Platt, Merrill Soule, Co.

Adjournment 12:30 P. M.

Wednesday Morning, June 6th, 1923

Closed Session—business meeting.

Meeting called to order 9:30 A. M. by President Lawellin. Minutes of the 1922 convention approved as printed in the July, 1922, number of the Journal. Report of President. Report of Vice President. Report of Chairman of the Executive Committee. Old business

Wood moves that the new constitution as proposed by the Executive Committee be approved and adopted, seconded.

In the discussion that followed the new constitution was read.

Constitution of A. A. C. C.

Membership

Section 1. The membership shall be restricted to those persons having had at least two years of chemical training in some accredited school.

Section 2. All applications for membership must be passed upon by a body known as the executive committee, their decision to be final.

Section 3. Those persons having one year's experience in laboratory shall be admitted as associate members at the same fee as active members. Their qualifications being determined by the Executive Committee. Such members are not to have any active part in the business meetings of the Association.

Associate members can become active members after five years of continuous membership upon unanimous recommendation of the executive committee.

Section 4. Honorary members may be elected by a three-fourths majority vote of the members present at a regular meeting. The name of the candidate to be entered by an active member of the Association.

Section 5. Application for membership must be made in writing and shall be proposed by at least one active member of the Association.

Officers

The officers of this Association shall be President, Vice-President Secretary-Treasurer, Managing Editor and Chief of the Editorial Staff.

Section 2. Election of officers shall be by ballot at general meetings. There must be at least three nominations of active members for each office to make the election valid.

(a) In order to be declared elected, the nominee must secure a majority of all votes cast.

Section 3. Duties of officers:

(a) The President shall preside at all meetings and be the official head of the Association.

(b) The Vice-President shall preside at all meetings in the absence of the President, and assist him in the duties of the office. He shall also act as Chairman of the Executive Committee.

(c) The Secretary and Treasurer shall keep a record of the minutes of the meetings, send out notices to the members and handle all correspondence of the Association. He shall collect all fees and moneys due the Association and pay all bills, by check, such bills and checks to be countersigned by the Chairman of the Executive Committee.

(d) The President and Chairman of the Executive Committee shall jointly select three active members of the Association to act as an Executive Committee.

(e) It shall be the duty of this committee to investigate the qualifications of applicants for membership. This committee to report to the association in general session. This committee shall cooperate with the President in carrying on the business of the Association between meetings. It shall be the privilege of the president to vote in the meetings of this committee.

(f) The President shall appoint three active members to act as an Auditing Committee. This committee shall report at all regular sessions. It shall audit the books of the Association at any time by request of the President.

(g) The Managing Editor shall publish the Journal.

(h) The Chief of the Editorial Staff and the President shall appoint two active members to act as an editorial staff.

(i) The Editorial Staff shall prepare the material for the official organ of the Association and submit same to the Managing Editor for publication.

Fees

Section 1. The application fee shall be ten dollars, which includes first year's dues. The fee must accompany the application; the fee to be returned in case the application is rejected or the applicant fails of election.

Section 2. The dues in this association shall be five dollars (\$5.00) per annum. This shall include subscriptions to all publications of the Association.

Section 3. Honorary members shall be exempt from dues and fees.

Section 4. Assessments not to exceed one year's dues may be levied when the current expense of the Association make this necessary. The

treasurer with the consent of the Executive Committee may levy said assessment.

Section 5. Failure on the part of any member to pay his dues or assessments within one year after due shall be regarded as resignation.

Section 6. All annual dues must be paid in advance, the membership card constituting a receipt for the same.

Elections and Meetings

Section 1. Meetings shall be held annually at such time and place as may be determined by the Executive Committee.

Section 2. In all general meetings an attendance of at least one-third of the active members of the Association shall constitute a quorum.

Section 3. The officers shall be elected to serve for a term of one year, or until a successor is elected.

Section 4. Honorary and Associate members shall have the privilege of attending all general meetings and the privilege of the floor, but shall have no vote.

Amendments

Amendments to this constitution may be made at any general meeting; a two-thirds majority vote of the members present shall be necessary to carry.

With the consent of second, Wood withdraws motion. Chittick moves word "membership" in section 3, par. 2 under membership, be changed to read "experience." Seconded. Chittick withdraws motion. Landstrom moves Section 1 be changed to read with the addition of "or equivalent in experience." Seconded. Carried. Wood moves the convention accept that part of the constitution which deals with officers and duties of officers. Seconded. Carried. Lentz moves adoption of Section 2, relating to elections and meetings. Seconded. Carried.

Election of Officers

Following officers were elected:—

President—M. J. Blish.

Vice-President—R. B. Potts.

Sec.-Treas.—R. K. Durham.

Managing Editor—J. R. Hess.

Editor-In-Chief—Dr. C. H. Bailey.

New Business

Report of Auditing committee..

Ferrari reports that statements are acceptable to both Societies. Report accepted.

Banquet Committee reports that arrangements have been made for a banquet Thursday at 7:00 P. M.

Motion by Lawellin that afternoon session be called off. Seconded. Withdrawn. Motion that no banquet be held; seconded, carried.

Loomis moves entertainment committee be instructed to arrange for luncheon Friday noon. Seconded, carried. Loomis, Landstrum and Wood

appointed to make the necessary arrangements.

Adjournment until 2:00 P. M. moved, seconded and carried.

Wednesday Afternoon, June 6th, 1923

Meeting called to order at 2:00 P. M. by Pres. Blish.

Bailey moves that dues be made to fall due on Jan. 1st instead of June

1st. Seconded. Carried.

Moved and seconded that the six sections of the constitution on fees be adopted. Carried.

Moved and seconded that articles on elections and meetings be adopted. Carried.

Rport of Chairman Potts of the Official Methods Committee.

Report of Methods Committee of A. A. C. C.

Moisture:

1—Cool in a desiccator *to room temperature* and weigh immediately after reaching room temperature.

Ash:

2—Ignite in an electric muffler furnace at just below dull red heat at *approximately 475 Deg. Centigrade* for an hour after which the temperature may be raised as high as 560 degrees Cnetrigrade.

3—Cool in desiccator *to room temperature* and weigh.

Protein:

4—With the exception that the use of zinc in any form as ebullition agent be eliminated substituting either pumice or porous plate.

Protein—Wheat Meal:

5—Determination to be made on *a thoroughly representative sample* of the clean wheat meal, etc.

Tentative Methods

6—Moisture in vacuo.

(1) Flour, feed, wheat meal, etc.

Place five grams of weighed sample into atared moisture dish in a vacuum oven at a temperature of 100 dgrees Centigrade and dry to constant weight at 29 inches of mercury vacuum. This will consume approximately 90 minutes. Release vacuum through sulphuric acid comprising about 10 minutes, open oven; replace covers on moisture dishes, cool in desiccator to room temperature and weight.

When using this method it shall be so stated upon report, or if used in comparison with any dry method the proper factors shall be deducted from the result found by vacuum. These factors will range from .5 to .8 of 1% dependent upon local conditions in the laboratory.

Standardization of 10th Normal Solutions:

(1) Barium Chloride Method for Sulphuric Acid.

(2) Benzoic Acid Method for Caustic Soda.

(3) Electrometic Method.

Barium Chloride Method for Sulphuric Acid

Draw off 25 cc. H_2SO_4 , add 5 cc. of a solution made by putting $2\frac{1}{2}$

c. c. conc. HCl in 57 c. c. H_2O , and then add 50 c. c. H_2O . Heat to boiling and add 20 c.c. boiling $BaCl_2$ solution (1.62gms. $BaCl_2$ in 90 c.c. H_2O) all at once with constant stirring for two or three minutes, then let stand. At end of half hour (after testing for complete precipitation) decant liquid through filter. Wash precipitate by decantation with hot water and subsequently upon the filter with hot water until filtrate is free of chlorine. Dry, ignite, and weigh (Method is taken from George McPhail Smith's Quantitative Analysis. Author claims there are unavoidable errors with $BaSO_4$ method but that by using concentrations specified, the errors are kept to a minimum and compensate each other).

Benzoic Acid Method for Caustic Soda

Observe the following precautions:

1. The acid should be carefully fused before use in a covered glass or platinum vessel placed in an air-bath. The temperature during fusion must not rise above 140 degrees C.; it is best to keep it below 130 C. and to cease heating as soon as fusion is complete. (Fusion is unnecessary unless a high degree of accuracy is desired. Titration carefully made check to $\frac{1}{2}$ parts in 10,000 and consistent differences as great as 6-7 parts in 10,000 have been observed between fused and unfused materials which have stood in the laboratory for $\frac{1}{2}$ years.)

2. The acid should be dissolved in alcohol (about 20 c.c. for a 1-gram sample) and a blank test made upon the same volume of alcohol so that the necessary correction may be applied in the subsequent titration.

3. The titration must be made in the cold with carbonate-free alkali and the necessary precautions taken to prevent the access of carbon dioxide from the air during titration. Phenolphthalein is the most satisfactory indicator.

Lentz moves adoption of revised moisture method; seconded, carried.

Warren moves adoption of revised moisture method; seconded, carried. words "avoid fusing the ash." Seconded. Lost.

McVey moves adoption of ash method as read by Potts. Seconded. Carried.

Warren moves adoption of protein methods as they stand at the appointment of a committee to investigate them. Seconded.

L. H. Bailey move amendment that committee compare its results with the methods of the A. O. A. C. Motion withdrawn.

Bailey moves to lay motion on the table. Seconded. Carried.

Convention goes into executive session for members only.

Dr. Bailey moves that, of the cash balance shown on final report of the treasurer of the A. S. M. B. T., \$2.00 each be set aside to pay cost of sending 1923 Journal to A. S. M. B. T. members, and that, not to exceed 60% of the remainder be set aside for promotion of Journal. Seconded. Carried.

Bailey moves that editors with the approval of executive committee be authorized to accept money from those wishing to underwrite the Journal. Seconded. Dunlap moves an amendment that C. H. Bailey and associates be appointed to solicit and take care of such funds. Seconded. Carried. Amended motion carried.

Adjournment 4:00 P. M.

Thursday Morning, June 7th, 1923

Entire day's program held at the American Institute of Baking.

Meeting called to order by Pres. Blish at 9:25 A. M. at the American Institute of Baking.

Moved and seconded that business meeting be held Friday afternoon instead of Saturday morning. Carried.

Paper—"Some Aspects of Enzyme Action in Flour Strength and Fermentation Control," by L. A. Rumsey, American Institute of Baking.

President appoints executive committee as follows:

R. B. Potts, Chairman; M. E. Schultz, L. A. Fitz, Chas. G. Ferrari.

Paper—"Building the Quality Loaf," by O. W. Hall, American Institute of Baking.

Paper—"Moisture Determinations," by H. Godfrey Nelson, International Milling Co., New Prague, Minn.

Address by Dr. Barnard on "Eat More Wheat."

Lawellin moves that Convention go on record as favoring the "Eat More Wheat" campaign and that at least ten delegates be sent to the National Wheat Conference at Chicago.

At 12:30 adjournment until 2:00 P. M.

Thursday Afternoon, June 7th, 1923

Meeting called to order at 2:00 P. M.

Paper—"Bread vs. Vitamines," by Dr. C. B. Morison, American Institute of Baking.

Paper—"Protein Content vs. Texture vs. Kernel Weight in Southwestern Market Run Hard Winter Wheat." By W. L. Frank, Sherman Grain and Cotton Exchange, Sherman, Texas.

Visit through the Institute Bakery.

Friday Morning, June 8th, 1923

Meeting called to order by the President at 9:30 A. M.

Paper—"Examination of Some Self Rising Flour," by L. H. Bailey, U. S. Bureau of Chemistry.

Paper—"Chemical and Physical Changes of Some Constituents of Flour as Affected by Bleaching," by Dr. J. C. Baker, Wallace & Tiernan Co., Newark, N. J.

President appoints Methods Committee as follows:

L. H. Bailey, Chairman; J. R. Hess, C. H. Bailey, C. B. Kress, M. R. Warren, C. E. Mangels.

Mr. L. H. Bailey suggests A. A. C. C. have representatives at A. O. A. C. meeting next fall to make suggestions regarding official methods.

Following committee appointed by the President.

Inter-allied Committee—M. E. Schultz.

Cooperative Methods Committee—H. E. Weaver.

President requests Dr. Dunlap to fill in blank form for delegate to attend National Wheat Conference June 19-20, 1923, C. J. Patterson, C. H. Bailey, H. E. Weaver and A. A. Heon also suggested.

Paper—"Checking Protein Determinations," by M. R. Warren, Quaker Oats Co., Cedar Rapids, Iowa.

Paper—"A Suggested Control for Checking Nitrogen and Protein as Determined by the Kjeldahl Method," by S. J. Lawellin, New Ulm, Minn.

Paper—"Relation of Bakery and Mill Laboratory," by Rowland J. Clark, Goerz Mill and Elevator Co., Newton, Kansas.

At 12:40 adjournment until 2:00 P. M.

Friday Afternoon, June 8th, 1923

Meeting called to order by President at 2:00 P. M.

Dr. Morrison, Chairman of committee to prepare preamble for the Constitution reads preamble as drawn up.

Dr. Morrison moves wording of preamble be held up until further wording is completed. Seconded. Carried.

President instructs committee to report as soon as preamble is completed.

Moved and seconded that invitation from San Francisco to hold next convention in that city be referred to the executive committee. Carried.

Report of committee on resolutions.

Resolutions

The American Association of Cereal Chemists convening in the Sherman Hotel, Chicago, June 4th to 9th. 1923

BE IT RESOLVED, that our ASSOCIATION extend to the management of the Hotel Sherman our sincere thanks for the fine accommodations as well as cooperation given us while in convention.

BE IT ALSO RESOLVED, that we express our deep appreciation to the American Institute of Baking for the use of their class room and the very excellent program and arrangement for visiting every department of their fine institute.

BE IT FURTHER RESOLVED, that we extend to our fellow-workers, the Association of Operative Millers, our thanks for their invitation to hold a joint convention and the spirit of cooperation expressed throughout the entire proceedings.

BE IT FURTHER RESOLVED, that we extend our vote of thanks and appreciation to the Messrs. Dillon and Ross for their support to help make our convention a success.

BE IT FURTHER RESOLVED, that the National Miller also be given a vote of thanks for the fine publicity given our convention and Association during our stay in their city.

Adoption of report moved, seconded and carried.

C. E. Mangels moves that Editorial Staff and Managing Editor select title for the new Journal. Seconded, carried.

Report of Journal Committee read and approved.

Report of Journal Committee

There will be six issues of 50 pages each at \$3.00 per annum.

Reprints to only be furnished to authors on request, at cost.

Managing Editor to handle business end of the Journal.

Editor-In-Chief to have charge of scientific materials. He shall appoint a suitable number of associates to assist in this work.

In case of papers presented at convention by members, they shall become property of the Society.

That membership shall be as of the first of January of the year of election, and Journals supplied for the calendar year elected.

H. E. Weaver appointed to attend National Wheat Conference.

Moved by Hendel that Dr. C. H. Bailey be alternate delegate to speak at National Wheat Conference. Seconded, carried.

Moved by Hendel that President appoint a committee which has power to assess chemists a fee to cover cost of sending out samples for the purpose of checking ash, protein and moisture. Lost for want of second.

Frank moves that Methods Committee prepare an accepted average of results and that the names of those collaborators checking within the limits of experimental error be published on an honor roll; seconded. Motion Lost.

Wood moves that as an Association we do not continue the Question and Answer column in 'Modern Miller.' Seconded, carried.

Convention adjourned by motion at 4:30 P. M. June 8th, 1923.

R. K. DURHAM,
Secretary-Treasurer.

Report of Allied Association Committee

August 6, 1923.

Mr. A. P. Husband,
Sec. Millers' National Federation,
Chicago, Illinois.

Mr. M. F. Dillon,
Sec. Association of Operative Millers,
Kansas City, Mo.

Mr. R. K. Durham,
Sec. American Association of Cereal Chemists,
Kansas City, Mo.

Dr. H. E. Barnard,
Sec. American Bakers' Association,
Chicago, Illinois.

Gentlemen:

At the meeting of the Allied Associations Committee held in Chicago in June, which was attended by representatives of your respective Association, there was a discussion relative to insect pests in flour mills, warehouses and places where flour is stored, and it was deemed advisable to call the attention of the various Associations to the desirability of carrying on a continual and perpetual campaign against insects in plants. The holding of old goods in warehouses and piling of new on top or in front of

same induces favorable conditions for insect life. The second-hand sack curse and similar practices that increase the opportunities of breeding insects and introducing them into plants should be guarded against.

Will you not kindly call the attention of your members to the insect problem and caution them in regard to the same and urge that they carry on a continuous campaign for eradication and prevention?

Sincerely yours,

HUGO ROOS,

Sec'y for Allied Associations Committee.

Second Meeting of Allied Associations Committee

The Allied Associations Committee met in Chicago, Ill., on Wednesday, June 5, 1923, at the Hotel Sherman, there being present: Messrs. Hardenbergh and Snyder, for the Millers' National Federation; Fredel and Lawson, for the Association of Operative Millers; Weaver and Schultz, for the American Association of Cereal Chemists;; Dr. H. E. Barnard, for the American Bakers' Association.

Absent: R. L. Nafziger, for the American Bakers' Association.

Mr. Hardenbergh, chairman, presided during the meeting.

Mr. Hardenbergh gave a report of the conference held in Washington in connection with the moisture content of flour and paid a high compliment to the work done by Prof. Snyder in this connection.

The representatives of the Association of Operative Millers having presented a resolution passed at the annual convention of the body in June, 1922, in reference to the mixing of spoiled or rotten wheat into wheat intended for human consumption and suggesting the elimination of this and similar practices, the Allied Associations Committee determined that the complaint was of sufficient importance to warrant referring the same to the Millers' National Federation for consideration.

The Allied Associations are to be advised of the desirability of carrying on a continual and perpetual campaign against insects in plants. The holding of old goods in warehouses and piling new goods on top or in front of the same, the second-hand sack curse, and similar practices that increase the opportunities for breeding insects and introducing them in plants, should be guarded against.

The problem of the miller and baker being mutual in endeavoring to present the best possible loaf of bread, it was resolved that Mr. Husband, secretary of the Millers' National Federation, Mr. J. M. Hartley, secretary of the American Retail Bakers' Association, and Dr. H. E. Barnard, secretary of the American Bakers' Association, be requested to confer in reference to the drafting of a letter to be sent to members of the Millers' National Federation and to bakers, suggesting the co-operation of millers and bakers with the American Institute of Baking in arriving at settlements in connection with complaints effecting the baking quality of flour.

It was the concensus of opinion, that for the present this committee should take no action in connection with the moisture content of flour problem, but await the outcome of the conference held in Washington by the representatives of the Millers' National Federation.

Adjourned.

HUGO ROOS,

Sec'y for Allied Associations Committee.

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The American Association of Cereal Chemists

1915—

THE REASON

(Editorial taken from the first Journal published by the American Association of Cereal Chemists and seems worth of re-publication)

On the 8th of May, 1915, in Kansas City, Mo., a few chemists that were interested in cereal work met to form an organization for the advancement of the science as applied to cereal analysis. They were all operators in laboratories in which the work was principally the control of flour milling operations.

In the course of their experience each one had been faced with the question: "Why can't your chemists agree on your reports?" It must be acknowledged that there are grounds for such queries, and that, though they are explainable to the satisfaction of the chemists, it does not eliminate the fact that it lowers the value of a chemical analysis in the eyes of the baker, jobber, or miller.

Each member present was there because he felt the need of associating with other chemists interested in the same line of work, with whom he could exchange ideas and discuss the various methods as practiced by others.

All realized that, if by means of discussion and investigation the best practicable method of procedure for each determination could be established, then standard methods could be outlined, and with that done, uniformity of results would follow.

This, then, is the object of the association which has taken onto itself the title of "THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS." To carefully consider methods of procedure and practice in cereal analysis by means of research and open discussion, and to draw conclusions which are representative of the convictions of the operators who are members. It is the desire to adopt methods which are as free of any scientific objections as possible, but at the same time lend themselves to the best advantage under the conditions that exist in the ordinary "control" or "commercial" laboratory. It is realized that there are many objections to be met each time that a standard method is adopted. There will be special reasons why certain points in any method should be done slightly different by different operators. All points that have a bearing on the results gotten by any method must be carefully considered and then the method that is the most scientifically exact and at the same time practicable, selected as the standard.

Every earnest chemist who is seeking to give his employer values received, will see in this movement an opportunity to increase his efficiency by joining with the members and giving and receiving in the efforts to achieve more uniform results. Flour and cereal chemistry has in the past, never seen any concerted efforts put forth for its benefit and now when the start has been made it would be a great boon to all if the interested ones would come forward and join in the united membership in the interest of a worthy cause.

It is the earnest desire that millers and mill owners will understand the object of this organization. STANDARDS is a word that has recently come into bad repute with many millers. We hope that such persons will not let the word deter them from reading the purpose and the ends to be accomplished by our body.

There is no intention of comparing milling methods or telling others the little things about our particular mill that puts it ahead of the other fellow. We will leave that to the millers themselves. The fact is that there are in almost all cases several ways to get the analytical data that makes the laboratory valuable. Because of the differing methods there is a greater liability of apparent discrepancies in the work of different operators working under different conditions. Then again there is a greivous lack of system in the manner of reporting the data. For instance, three laboratories might get the same loaf volume, and yet their reports would be utterly dissimilar, due to the fact that one reported in percentage, the second in cubic inches, and the third in cubic centimeters. Uniformity in this matter will only come through some such agency as our organization proposes to be.

Another thing: we wish to assure the mill owners that there is nothing of the character of a "UNION" in this movement. This is a movement for the good of the profession in that it will increase the efficiency of the individual and in so doing, increase his value to the employer. A wage scale is the last thing that the ambitious operator would care to have to contend with.

CONSTITUTION

American Association of Cereal Chemists

PURPOSE

The purpose of this association is to reach by means of research and discussion, agreement in the methods of analysis necessary in the cereal laboratory. The object to be accomplished is the establishment of standard methods of procedure in the analysis of cereal products.

MEMBERSHIP

Section 1. The membership shall be restricted to those male persons having had at least two years of chemical training in some accredited school, and practical experience in cereal chemistry.

Section 2. All applications for membership must be passed upon by a body known as the executive committee, their decision to be final.

Section 3. Honorary members may be elected by a three-fourths majority vote of the members present at a regular meeting. The name of the candidate to be entered by an active member of the association.

Section 4. Application for membership must be made in writing, and shall be endorsed by at least three active members of the association.

OFFICERS

Section 1. The officers of this association shall be: President, Vice-President, Secretary and Treasurer, Chairman of the Executive Committee, and the Editor.

Section 2. Election of officers shall be by ballot at general meetings. There must be at least three nominations of active members for each office to make the election valid.

Section 3. Duties of officers:

(a). The President shall preside at all meetings and be the official head of the association.

(b). The Vice-President shall preside at all meetings in the absence of the President, and assist him in the duties of the office. He shall also act as business manager for all publications of the association.

(c). The Secretary and Treasurer shall keep a record of the minutes of the meetings, send out notices to members and handle all correspondence of the association. He shall collect all fees and moneys due the association, and pay all bills; such bills to be countersigned by the chairman of the Executive Committee.

(d). The President and Chairman of the Executive Committee shall jointly select three active members of the association to act as an Executive Committee.

(e). It shall be the duty of this committee to investigate the qualifications of applicants for membership, and to report to the association in general session. The committee shall co-operate with the president in carrying on the business of the association between meetings. It shall be the privilege of the president to vote in the meetings of this committee.

(f). In the absence of both the President and the Vice-President, it shall be the duty of the Chairman of the Executive Committee to occupy the chair.

(g). The Editor shall prepare the material for the official organ of the association and turn it over to the business manager for publication.

FEES

Section 1. The application fee shall be five dollars. The fee must accompany the application; the fee to be returned in case the application is rejected or the applicant fails of election.

Section 2. The dues in this association shall be two dollars (\$2.00) per annum. This shall include subscriptions to all publications of the association.

Section 3. Honorary member shall be exempt from all dues and fees.

Section 4. Assessments may be levied when the current expense of the association make this necessary. The Treasurer with the consent of the Executive Committee may levy said assessment.

Section 5. Failure on the part of any member to pay his dues or assessments shall be regarded as resignation.

Section 6. All annual dues must be paid in advance, the membership card constituting a receipt for the same.

ELECTIONS AND MEETINGS

Section 1. Meetings shall be held semi-annually at such time and place as may be determined by the Executive Committee.

Section 2. In all general meetings an attendance of at least one-third of the active members of the association shall constitute a quorum.

Section 3. The officers shall be elected to serve for a term of one year, or, until a successor is elected.

Section 4. Honorary members shall have the privilege of attending all general meetings and the privilege of the floor, but shall have no vote.

AMENDMENT I

Amendments to this constitution may be made at any general meeting; a two-thirds majority vote of of the members present being necessary to carry.

AMENDMENT II

Amendment to the constitution, that those male persons having five years experience in laboratory, be admitted as associate members, at a fee of ten dollars each. Their qualifications being determined by the Executive Committee. Such members are not to have any active part in the business meetings of the association.

AMENDMENT III

Amendment to the constitution, raising membership fee from five dollars to ten dollars after June 1, 1920.

Amendment to the constitution, raising dues in the association from two dollars to five dollars a year.

AMENDMENT IV

Amendment to the constitution to strike out the word "male" in Section 1 of paragraph on membership. Also in Amendment II.

SUSTAINING MEMBERS

The sustaining members of this organization are milling companies and other organizations which have the interest of the cereal chemist and cereal chemistry at heart and wish to give them financial aid.

To increase the knowledge in cereal chemistry and to establish uniform methods of procedure and control of value to their employer.

Any information in regard to sustaining membership may be obtained from the secretary, Mr. A. A. Jones, The Hyland Flour Mills Co., 608 New England Building, Kansas City, Missouri.

The sustaining member has all the rights of a member except the vote.

A. A. C. C. OFFICERS AND COMMITTEES 1922-1923

President:—S. J. Lawellin, Milton Hersey Co., Ltd., Winnipeg, Man., Canada

Vice-President and Business Manager:—R. S. Herman, Ismert-Hinke Milling Company, Kansas City, Kansas

Secretary-Treasurer:—A. A. Jones, The Hayland Flour Mills Co., Kansas City, Missouri.

Editor:—J. R. Hess, William Kelly Milling Co., Hutchinson, Kansas.

Chairman Executive Committee:—W. L. Rainey, Larabee Flour Mills Corporation, St. Joseph, Missouri.

ALLIED ASSOCIATIONS COMMITTEE 1922-1923

A. A. C. C.—H. E. Weaver, St. Joseph, Mo.; M. E. Schulz, Salina, Kansas.

A. O. M.—P. H. Lawson, Portland, Ore.; M. M. Fredel, New York City.

M. N. F.—C. M. Hardenberg, Kansas City, Mo.; Prof. Harry Snyder, Minneapolis, Minnesota.

A. B. A.—Dr. H. E. Barnard, Chicago, Ill.; Roy Nafziger, Kansas City, Mo.

Inter Allied Associations Committee

H. E. Weaver, Chairman, 2 years; M. E. Shultz, 1 year.

Committee on Methods of Analysis

R. B. Potts, Chairman; J. R. Hess, A. A. Jones, M. C. Mann, M. E. Schulz, L. E. Leatherock

Sample and Referee Committee

R. S. Herman, Chairman; H. F. Fleming, A. R. Sasse.

STANDING COMMITTEES JUNE 9, 1922

Executive Committee

W. L. Rainey, Chairman; J. C. Wood, A. A. Heon, M. R. Warren.

Co-operative Methods Committee

M. E. Schulz, Chairman, 1 year; H. E. Weaver, 2 years; L. R. Olen, 3 years.

Auditing Committee

M. C. Mann, Chairman; P. M. Patterson, J. R. Hess.

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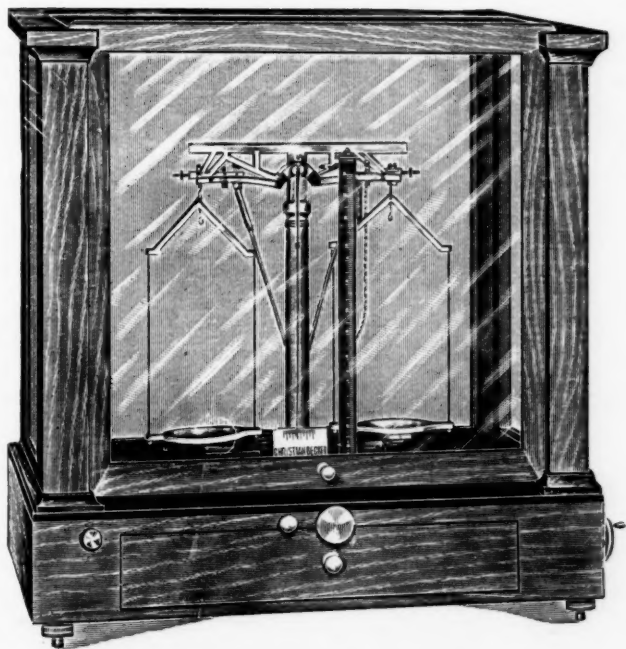
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JUNE 4-9, 1923

AMERICAN ASSOCIATION OF CEREAL CHEMISTS

All Passenger Associations of the United States have granted reduced rates to our 1923 Convention, to be held in Chicago, Ill., the week of June 4 to 9, 1923, on the certificate plan. Certain rules must be conformed to. Those going to the convention will buy regular one-way tickets to Chicago. At time of purchase you must ask for a CERTIFICATE, (not a simple receipt). Sign your name to the certificate. All agents will have full information for this event. Ask your railroad agent about it several days before your starting day.

Reduced rates will apply on all tickets at regular adult rates costing 67 cents or over. **ASK FOR CERTIFICATE WHEN BUYING.**

This means a fare of one-and-one-half, if conditions are complied with. Selling dates from all points are liberal. From far-removed sections the sale date is as early as May 30 to June 6, inclusive. **ASK YOUR AGENT ABOUT DATES.** He has the tariff and instructions, or can get them.

Some smaller railroads are not a party to Passenger Association agreements. In such cases you would buy a local ticket to the nearest point where they do have certificates, and through tickets.

Eastern lines of the Canadian Passenger Association, which embraces points east of and including Armstrong, Port Arthur and Sault Ste. Marie, Ontario, have granted the reduction. Western Canada lines did not grant reduced rates. Selling dates in Eastern Canada are May 31 to June 6, inclusive.

On the certificate plan return trip must be made by same route as the going trip. Tickets will be validated for return during the week of June 4 to 9 at Hotel Sherman. All tickets and certificates must be delivered to M. F. Dillon, Secretary of the Association of Operative Millers, at Hotel Sherman, Chicago, on arrival, for stamping and certification.

Return trip will be made up to and including June 13, 1923.

The reduced rates will apply only if we have 250 certificates presented. Remember this and be sure to get certificate when starting for Chicago, even if you do not intend to make the return trip.

Headquarters at Hotel Sherman.

Further information from the Secretary, promptly and gladly.

AMERICAN ASSOCIATION OF CEREAL CHEMISTS

A. A. JONES, Secretary

206 New England Bldg.

KANSAS CITY, MO.



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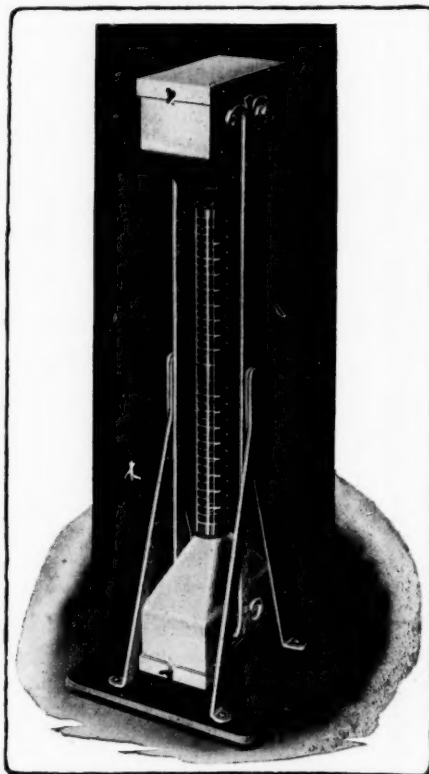
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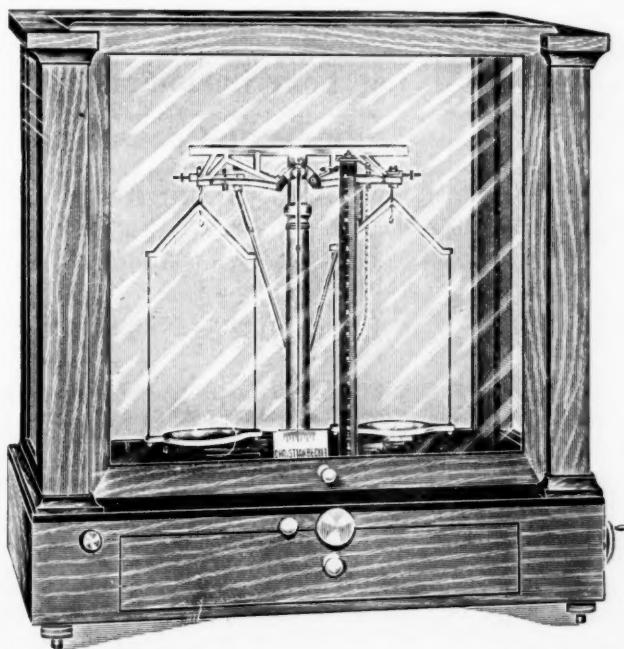
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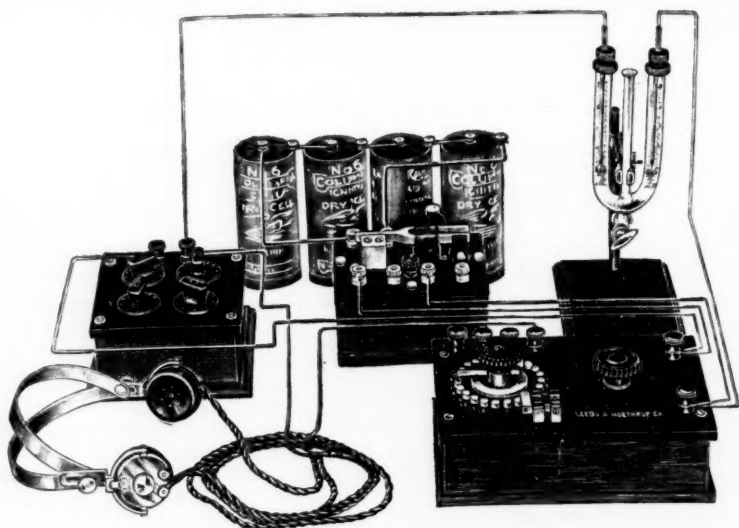
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ATTENTION LADY CHEMIST: In our last convention our constitution was amended to admit women to membership. Send in your application to Mr. A. A. Jones, Hoyland Flour Mills Co., 608 New England Building, Kansas City, Mo.



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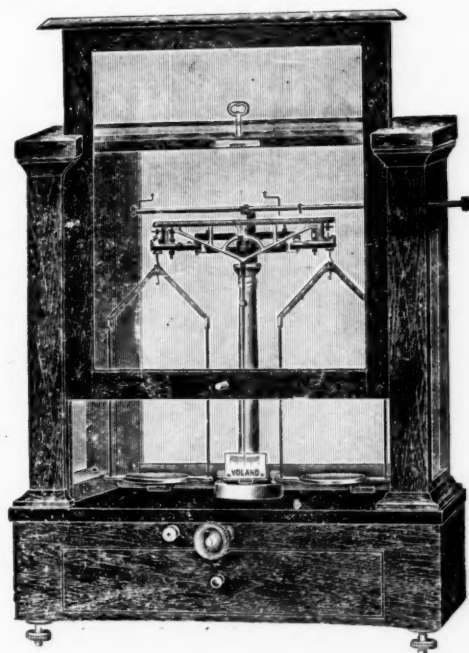
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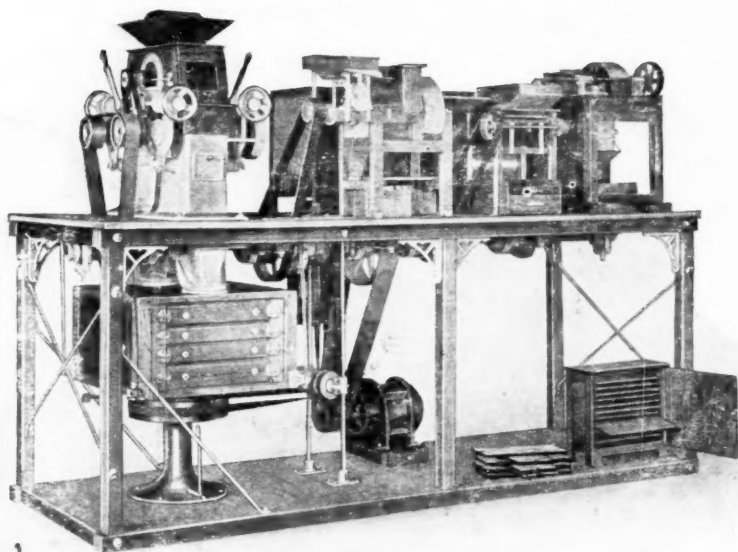
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